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TELEPHONE PATENTS.

THE expiry of the Bell telephone patent has thrown open a most useful invention to a far larger public than were enabled to take advantage of it whilst the patent existed. In saying this we have no intention of reflecting upon the attitude of the holders of the patent, or of lending any countenance to the suggestion that the protection afforded by the patent law has been strained. We are not sure but that a word may be advisable against the assumption that there is not entire liberty to the holder of a patent to "exploit" it in any way he pleases. The law protects him, and assumes that he will make the most profitable use of his opportunity. As a rule, the most profitable use is that which confers the greatest public benefit, and whilst we, in common with many others, have often found it necessary to criticise the methods of the holders of the telephone patents, it must be admitted that everybody should be the best judge of his own business.

The majority of those now using Bell telephones for the first time are somewhat surprised to find them talk so well. They have been for so long considered in the light of "receivers" only that their capabilities as transmitters had been overlooked. The utility of two Bell telephones in conjunction is certainly greater than was supposed, though the numerous cases in which battery transmitters are either necessary or much more advantageous will lead many to look forward to the time when they are also free to the public. We purpose therefore giving a brief *resumé* of the most important patents and their characteristics.

The first Edison patent (2,909, 1877) expires on 30th July of the present year. It has been the subject of so much litigation, that our readers are familiar with its principal features. The original patent had 30 claims, and shed them all except the second. In the amended specification, No. 2,909 * * *, this remains, with a slight verbal alteration, as the sole claim. "In an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of electric tension regulators, substantially as hereinbefore described, for varying the resistance in a closed circuit, substantially as set forth." The life of this patent has nearly run its course, and the necessity of the claimed combination in a telephone transmitter still exists, in spite of all the efforts made to overcome it. To a layman, the definitions of either a "diaphragm" or a "tension regulator substantially as described," offer some difficulties, but he would probably find the diaphragm the easier of the two, though the legal mind found it perhaps the more difficult. What is a diaphragm? "Something which separates something from something else," says one authority. "Applied telephonically, a diaphragm is anything capable of transmitting sound waves to an electric tension regulator," in effect replied the expert witness, and the decisions of the highest authorities have recognised it as practically correct. The combination of these two essential features being free from and after July 31st next, it becomes of interest to consider how other patents affect the choice of either. We have not space to refer to all, but select the most important, and those which govern the really practicable types.

The Hunnings patent (3,647, 1878), expires 16th September, 1892. It cites the "well-known" Hughes microphone and the Edison carbon telephone, and the patentee lays no claim to the principle of using carbon in the solid or the consolidated form of those two instruments, for the purpose of increasing or diminishing the resistance of the telephonic circuit, nor the coating of fibrous substances with carbon to produce the same results. There are two claims covering (1) the use of finely-powdered carbon, or like conductor, as a means of varying the resistance of a telephonic circuit by the vibrations of a thin metallic or metal-covered diaphragm enclosing it, controlled by sound waves impinging upon it; and (2) a telephone transmitter consisting of a layer of finely-divided carbon, or similar conducting material, in a loose and free state between thin metallic or metal-covered diaphragms in a suitable case. The Hunnings patent is of interest from the fact that experience has confirmed the views of the inventor as to the suitability of the material. In the specification, he says:—"The details can be indefinitely varied, the great

feature being in the use of carbon used in a state of fine loose powder, not in any way pressed or consolidated, as I find the loose particles of conducting matter to be most delicately sensitive to sonorous vibrations." The words, "pressed or consolidated," refer of course to the compressed lampblack at that time used in the Edison transmitter. The claims follow somewhat closely the construction of the instrument shown in the drawing accompanying the specification, though the possibility of wide variations is contemplated in the foregoing extract. The Edison patent has raised the question, "What is a diaphragm?" We hope that the Hunnings patent is not destined to submit to judicial decision the question—What is a *thin* diaphragm?

The Blake transmitter is protected under specification No. 229, 1879, in the name of William Robert Lake. It does not expire until January 20th, 1893. This patent has two prominent features—(1) the fixing of the diaphragm by spring pressure on one of its faces; and (2) the method of mounting the electrodes. Preferably both electrodes are supported independently of the diaphragm, but pressing against it; both are mounted on springs; the tension of the springs is towards each other, and they are attached to a lever with a regulating screw. By means of this one screw the relation of contact of the two electrodes and their pressure on the diaphragm are easily regulated and maintained. Of the five claims, the first covers the mounting of the diaphragm, and the remainder relate to the electrodes and the lever for regulating them. They cover the pressing together of the electrodes, whether by means of one spring or two; the weighting of one of the electrodes to resist the movement of the diaphragm, and modify by its inertia the variation of pressure between the two electrodes; and the adjusting lever for regulating the tension of the electrodes together, and their pressure on the diaphragm. The Blake transmitter is an excellent example of an invention completed in all its details before it was patented. The drawing attached to the specification shows with extremely slight modifications the instrument as it is manufactured now. Having done excellent work, it is probable that the Blake will not be the form in which the combination of diaphragm and tension regulator will survive.

Crossley's patent (No. 412, 1879) is for compound microphones. It expires on 1st February, 1893. In the specification a "compound" microphone is defined as having three, four or more pencils, and six, eight or more surfaces, touching each other. An "ordinary" microphone is defined as having only one pencil and only two surfaces touching each other. The patentee being aware that ordinary microphones had been used as telephone transmitters lays no claim to them, but in his two claims confines himself to the compound microphones, whether constructed of carbon pencils or thin metal plates.

The action of all the tension regulators we have mentioned is claimed to be a microphonic action; they are known as transmitters under the generic name of microphone transmitters, but they have all an essential difference in form to Hughes's microphone, except the Crossley. Crossley says simple (or "ordinary") microphones have been used as transmitters, and "compound" ones have not, so I claim a compound microphone as my invention when used as a telephone transmitter. Hunnings's specification, which is of four and a-half months earlier date, refers to the Hughes microphone as well known, without any reference to the number of carbon pencils employed.

FOREIGN ELECTRIC LIGHTING CONTRACTS.

IT cannot be denied that English electrical firms who tender for foreign contracts for electric lighting, and especially those for the European continent, are placed at a great disadvantage. Not only is the cost of transporting electrical apparatus to its destination a considerable item of expense, but the import duties on the plant also tend to increase the amount of the contract price. Moreover, continental municipalities, as representing the public interests, are, excepting probably where native manufacturers do not exist, generally adverse to the introduction of foreign plant. This state of affairs is not likely to encourage English electrical firms to compete with their rivals domiciled either in the country from which tenders are invited or in an adjoining country. Some, however, do so. They devote considerable time to, and incur expense in, the preparation of estimates and in forwarding the latter to their destination. But what is the result? Only disappointment and loss of money, for, if we remember rightly, not a single public electric lighting contract has as yet been received from the Continent by an English firm.

Take, for instance, the towns of Copenhagen, Brussels and Sophia. In the first case, advertisements were inserted in various English journals asking for tenders for the fitting up with complete plant of a central station for the simultaneous supply of 14,000 incandescent lamps. Eventually, the contract, for which several English firms tendered, was given to Messrs. Siemens and Halske, who are now proceeding with the work. In the second case, the Brussels Municipality invited tenders for the supply of plant for a central station to electrically light that town; but after some months' delay, the Town Council decided, as already announced in a previous issue, not to accept any of the contracts, but reserved to itself the right of exploiting the proposed station. In the third case, the Bulgarian Board of Works asked for tenders for the supply of plant for a small central station to be erected in Sophia; and although the tender—which was the lowest—of Messrs. Egger & Co., of Vienna, was proposed to be accepted by the commission appointed to investigate the tenders, a further inquiry has now been ordered, yet, from the contract prices given in the REVIEW last week, and ranging from as low as £9,328 to as high as £48,000, it does not appear that the two English firms which tendered have any chance of obtaining the contract.

It seems as if, as the French proverb states, "*Le jeu ne vaut pas la chandelle.*" It cannot be expected that competition in the case of a foreign contract will be less keen than when tenders are invited for electric light plant at home. It is, indeed, rather the reverse, for in the former instance it appears to be only the best firms which vie with each other to secure the prize; whilst at home, although the number of tenders from firms of all classes may be more numerous, discrimination is rendered easier. The fact must, moreover, not be overlooked, that when lighting contracts

are open in this country no foreign electrical firm offers to compete—possibly because the idea prevails on the Continent that the sending in of tenders would simply imply a waste of time and money. There is certainly some truth in this, and the same may also apply to English firms in relation to foreign countries. There does not seem to be any more chance of electrical firms becoming more successful with regard to foreign contracts in the future than has been the case in the past, and the best policy to be adopted henceforth by contractors would appear to be to give careful consideration to the possibility of the contract being obtained by one of themselves, and not to lose time and money in sending out tenders indiscriminately.

NATIONALISING THE TELEGRAPH.

UNDER this heading an article, by Mr. Erastus Wiman, has been published in *Frank Leslie's Illustrated Newspaper* (America), and reproduced in the *Electrical World*. The article is a dissertation on the advantages and disadvantages of the telegraph systems of the United States being acquired by the State and worked in connection with the Postal Telegraph department. In the course of the arguments, the writer refers to the Postal Telegraph system as carried on in Great Britain, and states that in England the telegraph is in *every* post office. This statement is in itself sufficient to indicate the writer's knowledge and capability of dealing with the subject he handles; he says that the "disadvantages of governmental control of this important and essential instrumentality of commerce would not only be felt every day—every hour—in the ordinary course of business, but especially in circumstances of great disaster, resulting from storms, fires, &c., the slow-moving policy of Government would be painfully evident, for instance, in such circumstances as overtook the Western Union Company at its recent fire in New York." Now, presumably Mr. Wiman knows something about the Government of his own country and its "slow-moving" policy, but why he therefore concludes that all Governments are the same is not obvious; judging from his writing he is profoundly ignorant of what is going on outside his own narrow circle; he says, "the advocates for postal telegraphy are always pointing to the experience of European countries, and especially Great Britain, forgetful that the economic conditions that prevail there and here are as widely different as it is possible to conceive. For instance, in the matter of wages of operators, the rate which is received by an intelligent, expert electrician is twice that which is received by the dull, stolid, stupid post-office clerk in half the stations of England. There has been no progress whatever in electrical science in England since the Government took hold of the telegraph, and there will not be in this country if the Government assumes control." Possibly the latter statement may be true; we are not concerned, and do not possess sufficient information, to defend the U.S. Government against the charge, but we emphatically assert that Mr. Wiman is talking the veriest nonsense when he states that in England "no progress has been made in electrical science." Does the writer suppose that the large total of over 50,000,000 messages per annum now reached is attained by simply using an increased number of the antiquated instruments in use by the various telegraph companies at the time of the transfer to the State. Anyone acquainted with the Postal Telegraph Service would know that a complete remodelling of the whole of the old apparatus and the introduction of new has been carried out by the engineers in the service of the Department, and further, that so satisfactory has been the working of the fast-speed apparatus (the Wheatstone automatic), that when a few years ago an American invention which was to do 1,000 words a minute, failed to give more than 35 on a circuit on which the Wheatstone worked at 200, an order for 12 complete sets of the Wheatstone came from the States, and these instruments are, we understand, working there to this day. Why is it that we hear of no Delany multiplex apparatus in use in America; is it that its value is not understood, or that it is found to be unworkable? We in England have appreciated its value, and by dint of perseverance in remodelling and rearranging the original types of apparatus have produced a workable system which is doing good service. Has Mr. Wiman ever seen a fast speed repeater board? We imagine not, or he would not talk about electrical science having made absolutely no progress. We take up a number of the ELECTRICAL WORLD and we find descriptions of apparatus of the "Post Office pattern;" why copy English apparatus if no progress has been made in England? Again, we noticed an advertisement to the effect that apparatus was made *equal to the best European manufacture*; this indicates a curious general standard of make in the States. Speaking of telegraph rates we notice the following; "As to the rates of telegraphy, there is always a great attraction to governmental advocates in the sixpenny rate of Great Britain, forgetful that a vast deficiency is every year charged up against the Post Office Department for the indulgence in this absurd reduction to a rate less than the cost of transmission." Never was there a more incorrect statement; a considerable deficiency has, it is true, to be made up each year, *but it is not the consequence of the introduction of the sixpenny rate*; the deficiency to be made up is that due to the interest which has to be paid on the excessive sum handed over to the telegraph companies for the purchase of their business by the State, and this deficiency is no greater with the sixpenny rate than it was with the shilling rate, in fact it tends to become less. One word more: it is stated that the British system carries 54,000,000 messages per annum, against 80,000,000 in the United States. How is it that with the vaunted company system in America, and the abused postal system in this country, the message work in America, with its hugh area of country, and immensely larger population, is considerably less than double that of England.

PREVENTABLE FIRES.

THE recent destruction by fire of Hurstbourne House, near Andover, the residence of Lord Lymington, M.P., adds one more to the already too long list of similar disasters that have occurred during the last year or so. It must also set the owners of all other country mansions thinking whether, in their own cases, every appliance has been adopted to diagnose and indicate the presence and position of any abnormal heat within the buildings; and, in the event of any such dangerous increase of temperature, whether there

are means at hand which can be brought into action with the instant promptitude requisite to stamp out an incipient conflagration, and avert more extended mischief and ruin. We can picture the possessor of one of our palatial English houses, noble by reason of its architecture and historical associations, and crowded with priceless works of art, family relics and heirlooms, sitting down, with the assistance of his surveyor, perhaps, and making a kind of debtor and creditor account of the risks from fire, and the apparatus for combatting the conflagration should it unfortunately break out. On the one side would be placed each item of lurking or possible danger which a minute and searching investigation into the construction of the house and its state of repair might adumbrate. In an erection of any extent—particularly if built of brick—it is surprising how many points or localities will be found which are but weak links in the chain of safety. Besides these faults which can be discovered and remedied, there are hidden ones whose existence can only be conjectured, and which must always remain a source of anxiety, and, therefore, should be regarded as an enemy's outpost to be carefully watched in the future. On the other, or credit side, would be placed a list of appliances, actually on the premises or precincts, provided and presumably ready for use, to counteract a sudden outburst of fire; these may consist of a fire engine—not invariably in working order—for use outside the house, with possibly a few *extincteurs* for the protection of the inside.

Compared with the number of dangerous points to be protected, we find a very meagre list of defences, which cannot be brought into play until the fire has been discovered, often not before it has been burning for some time and obtained a firm hold on the fabric, and the chance of saving the latter correspondingly lessened. The element of safety is entirely fortuitous. Not a fraction of certainty is introduced into the lines of defence, nor a particle of forewarning of any threatened outbreak can be anticipated. On this summing up the owner could not but feel in what a hollow protection he had been trusting in the past, and how irreparable would be the loss of his valuable pictures and other property which could never be replaced. His first impulse would be to enquire if there were not some more trustworthy means of guarding against his dreaded foe than those he had previously relied upon; means which would be automatic in action and never failing in sounding the alarm should occasion arise, and which would indicate the exact locality where the danger lies, however far it may be from the centre of life in the house. On finding that electricity can supply his wants, we feel sure his next step will be to fit up his house throughout with electrical safety appliances, consisting of fire alarms, indicators to exhibit the whereabouts of the fire, and apparatus electrically worked which on the first note of alarm automatically showers water on to the burning section of the building.

As electrical fire alarms can be arranged to ring a bell at any desired temperature, the inmates of a house can be informed of an extraordinary increase long before the heat has arrived at the pitch capable of igniting inflammable substances. Being forewarned by the electrical indicators, the ordinary appliances for the extinction of fires can be massed round the seat of trouble, the danger dealt with, and overwhelmed at once. A house thus equipped with electrical devices, together with hydrants and other means of quenching a fire, with every inmate trained in their use by frequent fire-drill, may be considered to be protected as far as human forethought can apprehend.

How different was it at Hurstbourne House! Appliances for indicating the seat of disaster—none! Engines to pump water into the fire—practically none! Assistance had to be called from places varying from two to seven miles away. The state of the roads must have rendered it impossible for a rapid arrival of fire engines, and as there do not appear to have been any hydrants available, the mansion was doomed from the first. All that could be accomplished was to save some of the treasures stored therein. We cannot but regret that canvasses by Sir Joshua Reynolds and Vandyck and a splendid portrait of Sir Isaac Newton by Sir Godfrey Kneller have perished in the flames; and we must express an opinion that the possessor of such inestimable works of art occupies the position of a trustee in the sight of the civilised world, and he should, therefore, adopt every conceivable precaution against damage by fire or other destructive agent.

The fire originated, it is said, in the principal bedroom, but the report does not state how it arose. There is nothing to be gained by surmises, but in our own experience we have known several troublesome fires break out through the ignition of soot which has penetrated at the back of the uprights to the mantelshelf, and set light to the skirting boards and floor. This is a specimen of a hidden risk. With every care in providing security to a house from fire there may still be some adverse fate that seals its doom. Yet the public may rest assured that five-sixths of the destruction of country seats by fire are preventable accidents if proper precautions were taken.

If combustible property can be thus protected to a vastly enhanced extent to what it is at present, there is no valid reason why the lives of persons who take part in performances for the public amusement should not be absolutely preserved from the chance of mishaps by fire. No longer should ballet girls, fastened to iron rods in pantomime scenes, and out of reach of help or assistance from the stage, be allowed to incur the fearful risk of a death formerly only meted out as a punishment for witches and husband poisoners. No longer should flaring gas lights be permitted in the wings, or, indeed, anywhere behind the scenes at the theatre. No longer should it be possible, as in the heartrending calamity at Leeds, to reproduce almost literally the fearful vision in Dante's "Inferno," and for unfortunate children to fall as—

> Dilated flakes of fire, as flakes of snow
> On alpine summit . . . . .

While in the seething, fiery mass of sufferers—

> Unceasing was the play of wretched hands;
> Now this, now that way, glancing to shake off
> The heat.

The public and the press should insist on the sole employment of incandescent electric lamps in places where an accidental spark may cause direful harm to life and heavy loss of property. It would not be too much to ask them to also urge on theatrical managers and others the necessity of preparing all textile fabrics, used for dresses or properties, in such a manner as to preclude a sudden outburst of flame should the material become ignited.

Should, however, the force of public opinion not be suffi-

ciently powerful to command an improvement in regard to these matters, it will then become a point of consideration whether the Legislature should not be asked to enact some regulations of a stringent nature to more efficiently protect our performers from calamity by fire.

Electricity Supply Companies and Consumers.

A CORRESPONDENT has been writing to the *Standard* complaining that, "By the Electric Lighting Act, 1882, all disputes between any person and an electric company as to compensation must be settled by an arbitrator appointed by the Board of Trade;" and giving five apparently very cogent reasons why this provision should be considered as an injustice to the public in disputes with electric companies. So far as we can gather from the facts disclosed in his letter, the *Standard* correspondent has no real ground of complaint. Everyone knows that where Acts of Parliament are passed conferring powers on companies (presumably for the benefit of the public) to compulsorily purchase lands, or break up streets, or do other acts which to a certain extent override the ordinary rights of the public, the company is, and must be, protected in the proper exercise of these powers, and unless the legislature expressly gives back the right to obtain compensation where damage has been caused, the public would have no right whatever against the company, be it a company for the promotion of a railway, canal, gas, electric, or any other kind of undertaking. In order to provide for the injury done to individuals by the exercise of these statutory powers, the Legislature has adopted the uniform practice of referring such questions to arbitration, and it is a matter of everyday occurrence that claims of this sort against all sorts of companies are so decided. In this respect, if there is any difference between the powers and rights of the public against any particular class of promoters, it is to the disadvantage of electric companies. To take an example, section 6 of the Gasworks Clauses Act of 1847, which provides for compensation to persons damaged by the execution of the powers granted, is not nearly so strongly worded in favour of the person injuriously affected as the corresponding section (sec. 17) of the Electric Lighting Act of 1882. To return to the particular grievance of the *Standard* correspondent, he appears to labour under an egregious error with regard to the scope of the powers of a Board of Trade arbitrater in matters pertaining to electric lighting, "all" disputes between any person and an electric company as to compensation are not compulsorily referred to arbitration, but only questions as to the amount of compensation to be paid by persons injuriously affected by the proper carrying out of the undertaking, and these questions, whether in the case of a railway, gas, water, or any other similar undertaking would also be referred to a similar tribunal. In cases outside this category the ordinary common law still applies. This being so, the only real grievance which remains to the *Standard's* correspondent is that he was unfortunately deprived of his costs by the arbitrator. Doubtless, as all the facts were before him, the Board of Trade arbitrator had a good reason for taking this course.

Theatre Fires caused by Electric Light.

SINCE the first announcements of the destruction by fire of two New York theatres came to hand we have watched each day for particulars which would also give the cause of the disaster, and at last we have it on the authority of Dalziel's Agency. A telegram from New York, dated the 4th inst., states that it has now been definitely discovered that the fires were caused by the crossing of two electric light wires. Now, as the electric light has been advocated as a means of theatre illumination on the grounds of its almost perfect safety and immunity from fire risks, we fear that if this news from America is confirmed it will leave a decidedly unfavourable impression upon the minds of those theatrical managers in this country who have adopted, or are about to instal incandescent lamps in their places of entertainment. The crossing of wires, which ought to be easily guarded against, is becoming a matter of too frequent occurrence, and we await with some anxiety further details of the causes which led to such a disastrous conflagration, as we are fain to believe that this report may have been originated by advocates of gas, or at least opponents of electric lighting. Probably our technical exchanges will be in possession of the facts, and from these we shall gather whether the catastrophe, if caused in the manner stated, was due to slovenly workmanship, bad wire and wiring, or inattention to the matter of safety wires. To whatever cause it may be assigned it seems pretty well known at the present day that electric lighting, although by far the safest means of artificial illumination in existence, has caused fires, and we have little doubt that these will be followed by others, unless the most stringent supervision is exercised by the contractor over his men, and by the technical adviser over the contractor. A theatre stage and its accessories should be looked upon in the light of a powder magazine, or dangerous coal mine, and similar precautions to those which are adopted for these, should be followed in such places of public entertainment.

The Benefits of Contention.

THE *Machinery Market* of the 1st inst. contains a short article on the controversy concerning electric light conductors which has lately occupied a portion of our correspondence columns, and which originated in a letter from Mr. Yeaman, of Liverpool. Our contemporary says that as all is fair in love and war, so there are some commercial people who appear to act on a similar principle. The result of the whole correspondence, the *Machinery Market* believes, will be a considerable accession of business to the Fowler-Waring Company, in which case it will not be likely to complain of the controversy. Whether this prediction is, or is not, fulfilled, we think that electric light conductors are likely to be in sufficient demand to tax the resources of the majority of manufacturers.

The London and Paris Telephone.

IN the number of *Electricity* for January 3rd, we find it stated with reference to the London and Paris telephone, that "Notwithstanding the great distance between the two exchanges, it is stated "*that it is not proposed to strengthen the current by any intermediate batteries*" !! this in a paper edited by the latter mentioned of the authors of "The Telephone," by Preece and Maier! With reference to the submarine cable for the line in question, we have various newspaper accounts as to its present position; one account states the cable is laid, another that it is on board the *Monarch*; as a matter of fact, the cable is still in the tanks at Messrs. Siemens's works, although it will be shipped before long, we believe.

Nationalising the Telegraph.

WITH reference to our article on this subject, we would remark that progress in a science does not necessarily mean new discovery and new invention, it also means the intelligent application of known facts, and it is a question whether those who appreciate and develop (not merely copy) the ideas of others, do not in many cases show the true spirit of progress quite as much as those who bring out inventions which they cannot or do not press forward. We admire, and even wonder at, the marvellous inventive faculty which our friends in America possess, but we think it only fair that they should ascertain facts before advancing arguments which will not bear examination.

ELECTRICAL PROGRESS IN SYDNEY.

[FROM A CORRESPONDENT.]

SINCE I last wrote to you both the Penrith and Lambton central stations have commenced work, and are meeting with great success.

The Lambton installation was opened with great *éclat* by the Mayoress on October 3rd, and the day was celebrated as a gala day in Lambton, with processions, banquets, brass bands, &c., in great style.

The plant consists of two 25 N.H.P. Fowler's compound engines, working with 140 lbs. steam pressure, with boilers of locomotion type, and two 1,000 volt 650-light Thomson-Houston alternating current dynamos and two exciters.

The street lighting, running into about 25 miles of main leads, consists of 160 25-candle-power lamps, in four circuits of 40 lamps each, run in series, the lampholders being fitted with the Thomson-Houston patent paper cut-outs.

The transformers for the house circuits, ranging from five lamps to 75 lamps capacity, reducing the potential to 52 volts.

The contractors, Messrs. H. H. Kingsbury & Co., of Sydney, received £6,350 for the work.

The Penrith installation is an almost exact copy of the Lambton one, with the exception of the engines, which are Hornsby's.

The street circuits are arranged in the same way as at Lambton, in four circuits of 40 25-candle-power lamps, run in series.

The switchboards are very handsome, and arranged, of course, so that any circuit can be run from any dynamo, and either dynamo from either exciter.

There are ampèremeters, voltmeters, and rheostats for each dynamo and exciter, as well as an ampèremeter and bank-board for each street circuit.

On November 10th, a public holiday in Sydney, the Thomson-Houston electric tram line between Waverley and Randwick was opened, and has been running very successfully, though opinions are very varied as to the overhead wires, which are suspended from cross-wires instead of poles with cross-arms.

The line is a very nasty one, and should form a good test of the capabilities of electricity as a traction power, as there are a number of curves and gradients on it, though it is comparatively only a short line of 1 mile 30 chains, with 2¼ miles of track, part being single track and part double.

The track itself is not by any means of the best, having been laid down some time and used for the heavy steam trams.

The grades go up to 1 in 10, and the curves up to 1½ chains. There is one curve of 6 chains on a 1 in 18 grade.

The car is built to carry 26 passengers seated, with standing room inside and on the platforms for about 40 more. To drive this load there are two 10 H.P. motors, and on the last trip I made by it there must have been at least 30 extra passengers, and the tram seemed to go all the better for it, stopping and starting in the middle of a pretty steep upgrade as easily as on level ground.

The engine room looks very well, having plenty of room, and the switchboard is very handsome and compact.

There is one Thomson-Houston dynamo giving 500 volts and 160 amperes running at 900 revolutions, and driven by a fine Armington and Sims engine of 100 effective horse-power running at 300 revolutions.

The boilers are old two locomotive boilers of 30 horse-power each, giving 100 lbs. pressure.

There are three cars fitted up, of which at present only one is running. The motors take a maximum current of about 36 amperes when running. The car looks quite brilliant at night with five 16 candle-power lamps to light it, one at each end, and a cluster of three in the centre. The effect is rather spoilt by oil head lamps and side lights, which are used, I suppose, in case of a breakdown.

It is proposed to extend the line to Coogee, which is about the worst existing line in Sydney for curves and steep grades, and the Public Works Committee are at present considering and taking evidence on the question of running an electric tram line from the city to Ocean Street, along William Street and New South Head Road. If this line is carried out it will be a very severe test, as it is up and down steep hills all the way.

The lighting of Newcastle on the Westinghouse system is proceeding apace, and the contractors, Messrs. Westcott, Marshall and Adams expect to have it completed by the end of the year. Electricians here are taking considerable interest in this installation, as it will be the first Westinghouse plant installed in the colony; and the Thomson-Houston system is installed so close by, at Lambton, which is practically a suburb of Newcastle, so that there will be an opportunity of instituting a good comparison of the two systems.

The borough council of Newcastle is at present engineering a bill through Parliament to allow them to distribute electricity to householders. It has already passed the second reading. This is the second time it has been before the Legislative Assembly, it having been thrown out on a technical point the first time.

On October 31st the retiring governor, Lord Carrington, performed his last public ceremony in opening a school of telegraphy in connection with the electric telegraph department. The new school has been started with a view of giving present and future telegraph operators a fair knowledge of electrical science generally. (I may add that your humble servant has been appointed instructor.)

The Williamson Company seems to have made a fair start, having got the contracts for lighting two new arcades and a new theatre, and are re-wiring Her Majesty's Theatre. Our arcade from Pitt Street to Castlereagh Street is, I believe, nearly completed.

The Sydney suburbs seems to be recognising the importance of electricity as a lighting power, and great activity is being shown all round.

Tenders close to-day, December 1st; for the lighting of the borough of Redfern (which is probably more nearly part of Sydney than any other suburb, as it contains the main railway station). At Burwood, another suburb, but on the outskirts, tenders were to have been closed last week, but the date was postponed for a fortnight at the request of one or two of the leading firms.

Two or three conferences have been held by the combined councils of Marrickville, Newtown, St. Peters, Macdonaldtown, Campbelltown, Lewisham, and Petersham, assisted by many of the Sydney electrical men, and it was finally decided at the last meeting, held a few days ago, to appoint a committee with power to go fully into the question and call for tenders. This is by far the most important electric lighting scheme out of the many at present on the tapis; as the suburbs mentioned cover a large extent of ground.

The borough councils of Paddington, Waverley, Woollahoa, and Randwick have also been consulting on the same subject, and Mr. Oxlade, whom I mentioned in my last letter, has submitted a report, but, so far, nothing definite has been decided.

Still another suburb, The Glebe, has the subject before them, and have had for some time, but they have not come to a decision yet either.

At Broken Hill there seems to be quite a boom going on. Messrs. Harrison and Whiffen, the Sydney representatives of the Crompton Company, are supplying and erecting a plant for the Broken Hill proprietary mine, and Messrs. Westcott, Marshall and Adams are performing a similar service for the Broken Hill Central.

In addition to these private installations, work is going on in the erecting of a Westinghouse central station plant for the town.

Mr. Hitchcock, an expert from the Westinghouse Company, is superintending the erection of the plant for Messrs. Westcott, Marshall and Adams, the contractors.

In fact, all round great activity is being shown by the councils of the various towns and boroughs to obtain information on the subject of electric lighting, and with Tamworth, Newcastle, Young, Lambton, Penrith, Broken Hill, Burwood and Redfern before their eyes they are beginning to recognise the fact that central station lighting has passed far beyond the experimental stage in this colony, and is now an accomplished fact.

There is plenty of competition for these plums, with Messrs. H. H. Kingsbury & Co., representing the Thomson-Houston and Edison Companies; Messrs. Harrison and Whiffen, the Crompton Company; Messrs. Westcott, Mar-

shall, and Adams, the Westinghouse Company; the Brush Company, and the Williamson Company, and companies in other colonies, all anxious and willing to have a finger in the pie.

I have just given a few bald facts with regard to our doings here, with the hope that you may find some items of interest to your readers.

WORKING OF RAILROADS BY ELECTRICITY.

VERY short papers followed by long discussions are an exception rather than the rule at meetings of American engineers, particularly with the Society of Mechanical Engineers. Mr. Willis E. Hall's paper on the very broad and problematic subject of working main lines of railways by electricity cannot have occupied more than fifteen to twenty minutes in reading. It is concise and to the point, the author devoting himself almost entirely to a comparison between a steam locomotive and an electric locomotive, enumerating the disadvantages of the former and the advantages of the latter. Mr. Hall points out the superior economy of stationary engines designed to work at a constant speed, utilising the highest grade of expansion as producers of of power at central stations, and which consume less than half the amount of fuel used in first-rate steam locomotives. The speed at which a locomotive engine can be driven has its recognised limits which are nearly reached. The piston speed of an engine with 24 inches stroke and 68 inches diameter of driving wheels, travelling at 60 miles an hour, would be about 1,400 feet per minute. An increase in the diameter of the driving wheels, with the object of decreasing the number of strokes, makes the engine correspondingly weaker, so that two very defined limits are placed before him who attempts to design an engine to haul the increasing weight of trains at a high speed. With electric locomotives it would not be necessary to have track tanks and water stand-pipes distributed throughout the line, which means a good deal to those who are aquainted with the attention and repairs (especially through the winter season) which such arrangements demand. Nor would it be necessary to carry the deadweight of tender containing water. No argument is necessary to indicate the advantage which electric motors would have over the steam locomotive where all the requisites of an engine must be incorporated in so many isolated places. The failures from leaky flues, broken eccentric straps, knocking a hole in the fire-box, blowing or knocking out cylinder heads, and the multiplicity of accidents which are happening every day on railroad lines, would be decreased to a marked extent. The reduction in the internal friction of the driving mechanism is also apparent. The loss in electric transmission in a station controlling a line of say 30 miles, would in the present state of the science, amount to some 50 per cent., which includes loss in dynamo, line, and that from an average working of motor. No attempt is made to show by actual figures the advantages or disadvantages resulting from the electric system, but it is merely desired to mention some of the many practical points which would be met, eliminated, or improved upon by the substitution of electricity to general railway working. Nor is it that its introduction is anticipated within a year or two; but we cannot but acknowledge that the application of electricity is becoming more general, and, from the rapidity of its development, its use for such purposes is hardly more distant than the most sanguine of its advocates would predict. The combination of electrical with mechanical engineering will bring about as much of a revolution in the future as it has done in the past, but in all its applications we must expect to see it walk before it can run.

OBJECTION TO HAULAGE BY LOCOMOTIVES.

Mr. Oberlin Smith, the president (a well-known railway engineer), touched upon a question which we have often advocated, and that is the adoption of electric motors on each car. Mr. Smith said that it is quite common, in speaking of the future of electric railroads, to assume that there must be a locomotive at the head of the train drawing the cars. This seemed to him a most absurd and ridiculous superfluity in the electric system, although with steam propulsion the running of this enormous mass of extra dead-weight was the only thing to do. The steam locomotive has developed by evolution, and is a wonderful and beautiful machine, probably the best we could have attained to so far, and doubtless destined to still greater attainments. But it has great disadvantages in the dead-weight due to carrying its boiler, fuel, water, none of which we can get over; also the limits of speed due to reciprocating motions and the difficulty of getting steam fast enough through the ports. With electric propulsion we have no such limits if we can contrive proper safeguards against derailments and collisions. Unquestionably, the future electro-locomotion will show a motor on every axle, or at any rate upon two axles of each car, and every car running as a unit, in which case they can run coupled together in a train or not, as may be convenient. Mr. Oberlin Smith most emphatically combats the idea that we must carry the enormous dead-weight of a locomotive for absolutely no reason. We have the weight of the cars, plus the passengers or freight, for purposes of traction, and this is more than abundant, even if we make our cars in future of lighter materials. In speaking of the lightness of the future conveyances by rail, the president said, that we shall not only use steel and aluminium, but paper, India-rubber, and other fibrous substances, which will give us remarkably light cars, far beyond anything we can now speak of practically. Just as a wheel-barrow is to a bicycle, so will these clumsy cars be to the future ones. To have a big motor car, loaded with tons of ballast to give it traction, is following the paths of steam locomotion, which are all right in themselves, but are totally wrong in the new field of electro-locomotion, where many of the conditions are so entirely different.

AN ARGUMENT AGAINST ELECTRIC RAILROADS.

"It is safe to say that unless there are some radical changes made from the ordinary design of electric generators, and in the method of transmission of the current to the motor, as well as a motor of greater efficiency, we will never see electric railroads operated in this or any other country." Furthermore, "*if steam transit would be permitted in our cities, the electric railroad business would not stand any kind of chance for competition.*" With these sweeping assertions Mr. F. A. Scheffler concludes his part in the discussion, which contains a lot of figures tending to prove that electric traction is and must be more costly than steam traction of the present day. We can only give a *resumè* of those figures. According to Mr. Scheffler, the ordinary locomotive when running at the average speed with an average load does work of not less than 300 H.P. Supposing the station to be built to have a capacity, to each 30 miles of section, of not more than one locomotive, the capacity of the generating station would have to be about 360 H.P., as the best forms of motors have an efficiency of only about 85 per cent. The cost of the station, including buildings and plant, complete, would be $37,000, without duplicate machinery. For operating expenses at the station, including depreciation of engines, boilers, dynamos, oil, waste, and wages of firemen and stokers, $8,355. The cost of coal, allowing 3 lbs. per horse-power hour, $3 per ton, is estimated at $8,322 per annum. Total operating expenses at the station, $16,677. Cost and maintenance of conductors, allowing a pressure of 2,000 volts and 20 per cent. drop in pressure with 112 ampères of current. A copper rod of 1 inch diameter would be required, and as this pressure is too high to be used with safety, the return should not be made through the rails but through a second copper rod. If the circuit is 30 miles long, 476,784 lbs. of copper will be needed, at a cost of at least $162,106. Six per cent. interest on this represents $9,726. As an overhead circuit would be cheapest, and as the weight is very great, the poles should not be more than 50 feet apart, necessitating altogether 6,300 poles, costing $15,750. Allowing $4,500 for erecting the line, we obtain the sum of $20,250 for this item; again, 6 per cent. interest thereon, $1,215. Depreciation may be put down at 2 per cent., or $3,627, giving a total annual expenditure of $31,245 for the operating expenses of station plant and 30 miles line.

The cost of operating the electric motor would be about the same as steam locomotive, and the first cost also about equal in both cases. The annual consumption of fuel in the steam locomotive would amount to 6,570 tons, costing

$18,710. Deducting this from the total operating expenses of the electric station, we find, that the difference is in favour of the steam locomotive to the extent of $12,475. The capital sunk in the station and line, complete, would be $219,856, and this amount of money would buy *about* 20 *new steam locomotives*. This is one way of showing a large balance on the wrong side which was neither supported nor successfully combatted by subsequent speakers.

Electric Railways Financially Successful.

It must seem, said Mr. H. C. Spaulding, in view of the preceeding statement, that the owners and stockholders in the three hundred electric railways now in operation (in the United States alone) must be on the verge of ruin. But "ignorance is bliss," and at the present time they seem to be running along smoothly, and to have no difficulty in earning dividends. It is useless to think, nevertheless, of running long roads by electricity with the present methods, just as it would have been useless in the first days of steam engines when it was considered unsafe to use a pressure of more than 20 or 30 lbs. to get the results which we to-day get by high pressure boilers and engines. The step which will solve the problem of electric transmission for railways, will be the use of high potential current along the track, and the use of low potential motors with an induced current. As far as the tractive force of electric locomotives is concerned, we should not claim anything more than the result obtainable by steam, but what should be emphasised a little more is the entire absence of reciprocating parts in the electrical apparatus. That has been touched upon as regarding the simplicity and consequent efficiency of the machines themselves, but mention has not been made of the effect on the track, the bridges, and structures over which the locomotives are to pass. In case of the application of motors to the separate trucks, the absence of a concentrated weight is worthy of consideration. Interest in the utilisation of water power is growing rapidly, and an electric road in the South, 200 miles in length, will, within the next few years, be operated by this method, with the low potential of 500 volts.

Mr. E. P. Roberts also referred to the financial question, and said that he knew a road where they are carrying only 3½ passengers per mile, receiving five cents for each person. They are operating twenty miles of double track, and are making money. On another road he knew of, the working expenses were less than 8 cents per car mile, including everything excepting interest on bonds, and that two cents covers this item.

Mr. W. E. Hall considered the figures of Mr. Scheffler far too high even at the present prices of electrical appliances. As the demand of a commodity increases the cost of production invariably decreases in proportion. As regards high tension currents, it must be admitted that vast strides have been made within the last few years. The jump from 2,000 to 10,000 volts, goes forcibly to indicate the sense of appreciation of the economical side of electric transmission. Mr. W. Forsyth stated that in getting estimates for a 7½ H.P. electric motor, he found that the figures from the various companies varied from $1,100 down to $400. Probably the $400 motor was as good as that for $1,100.

Mechanic *versus* Electrician.

Mr. S. J. MacFarren rose with some diffidence, to defend electrical methods, in an atmosphere so permeated with steam-locomotive sentiment. He congratulated the society on this commencement of the study of a subject which is growing faster than many realise. His experience has been that the electricians, so called, are not mechanics. A well known system of electric motors has been pronounced a mechanical failure in a careful report made by experts for a syndicate. These experts state that the gentleman who gave name to this company, and who had worked out the mathematics of electricity better than any competitor—that he so exhausted his brains on the electrical features as to leave nothing for the mechanical details of the problem, and has not yet reached a place where he can guarantee any sum which will cover the cost of repairs to the gearing and mechanism of his motor. Mr. Scheffler has proved by very skilful argument that it is impossible to operate a railroad by electricity. But it becomes constantly less safe to define possibility. Electricity is in no sense a rival, but in every sense an aid, to steam. There never was an industry commanding the amount of investment the electric railway has to-day which was guided by such ignorant advice as it is dependent upon. No more inviting field than electric propulsion opens for mechanical engineering, since 90 per cent. of the features of so-called electric "systems" are *mechanical* features. Sir Wm. Thomson has well said that the mechanical engineer needs to add but one-tenth to his knowledge to include the electric field.

Mr. T. M. Sweeny thought that in the consideration of the subject before the society the fact is lost sight of that electricity is merely a ready means of transmitting energy instead of a belt or a rope or other methods which have been employed at various times. The remark made by Mr. Scheffler, which was to the effect that, if steam cars were allowed to be run through the streets of cities, they would instantly supplant electric traction, was rather erroneous. That can hardly be possible, because for street traffic a higher class of labour is required to take care of and manage the steam locomotive than to take care of and manage an electric motor, and it is that feature which makes electricity so particularly applicable to street traffic. One can pick up a class of labour and educate it in a short time to handle the electric motor. There is too much disposition on the part of mechanical engineers to conclude that a requisite for electrical application is a lack of mechanical engineering knowledge. For a time, Mr. Sweeny was of that opinion, and thought that it would be but little trouble to correct many of the weak places in mechanical details, but he has generally found that they are too closely allied with the electrical question, and that what would certainly be a successful device if electricity was left out of the question, became anything else when connected with the electrical end. There is a great field for mechanical engineers in working out the details of the adaptation of electricity. But, in order to be successful, the engineer must also know a great deal of the properties of electricity.

THE ACTION OF ELECTRICITY ON MICROBES.

Electricity appears to be a determined enemy to microbes. The first researches concerning the action of electricity on microbes were carried out by M. Schiel, and go back to 1875. Observing that under the influence of the electric current certain mobile bacteria ceased to move, the author therefrom concluded that the electricity had killed them; but it is now known that immobile microbes are not dead microbes. Thus MM. Cohn and Benno-Mendelsohn again took up these researches, bringing thereto this corrective, that the microbes were not considered as dead only so far as their sowing was sterile. The experimental process employed by these gentlemen specially consisted in passing through a U-tube containing the nutritive solution the current from a few elements of a Marié-Davy pile. The nutritive solution had been sown previously, and when it became thick it was concluded that the current had remained without action.

In thus conducting their experiments, MM. Cohn and Benno-Mendelsohn saw that the effect of a weak momentary current was always *nil*. With a longer and a more intensive action, for instance, with the current from two powerful elements for twenty-four hours, the liquid near the positive pole remained intact, but the bacteria were not killed. It seemed even that this was the liquid which had become sterile, for it did not let a new sowing which had been introduced multiply, and, in reality, it had become strongly acid. With a current from three elements for twenty-four hours, there were at one and the same time observed at the two poles the death of the bacteria and the sterility of the liquid traversed by the current. But as it produced a profound chemical change in the cultivation, it was not possible to draw any conclusion relative to the direct action of electricity on the microbes. The experimenters, in order to avoid these decompositions produced by the current, then tried induction currents, but without obtaining appreciable results. With cultivations on potatoes, the chemical changes also occurred. The recent experiments of MM. Apostoli and Laquerrière, whose experimental preparations were not suffici-

ently described, but who appear also to have used a U-tube, have not advanced the question.

In order to free themselves from these causes of error, MM. Prochownick and Spoeth made use of an ordinary vase in bringing the electrodes together; the currents produced in the liquid by the gaseous emanations, while easily mixing the layers, constantly re-combining the elements dissociated by the current, and thus producing an average and persistent state, the duration of which was of only second importance. The authors, however, in acting by this process on the hay bacillus, the pus micrococus, and the carbuncled bacteriæ, only obtained insignificant results. In short, as M. Duclaux remarks, in all these experiments, if any sensible action has been found, it must be put down as a chemical action, and hitherto no one has been able to place in evidence a physical, direct action of electricity on microbes.

THE ELECTRIC LIGHT AT TURN.

[FROM A CORRESPONDENT]

THE community of Turn, in Bohemia (not far from the watering place Teplitz), in a municipal meeting held on December 17th, 1890, resolved on the introduction of the electric light, and for this purpose concluded an agreement with the Board of Inspection of Prince Clary's estates. The latter body stipulates to begin the erection of the electric central station within six months at the latest.

The community of Turn is certainly only a small town, as appears from the circumstance that for the public lighting of the streets, lanes, and open spaces only 55 glow lamps are projected, each of 55 normal candle-power, which are to burn for 5 hours during 250 evenings yearly. But Turn is a rising community with a prosperous industry, and as the projected electrical works are also to furnish current for the production of motive power, all the conditions for a lucrative development are present.

The agreement is made very favourable for the party supplying the current, and it contains some noteworthy stipulations, providing for an interruption of the work by external interference, such as, *e.g.*, the outbreak of a strike.

The most important stipulations are the following;—The community of Turn concedes to the Inspection Board of Prince Clary's estates the right to utilise the streets, lanes, and open spaces within the parish of Turn (in as far as it possesses the right of disposing of them) for laying down leads for conveying electric energy, whether above or underground, for the purposes of lighting, and for the transfer of power.

The community of Turn renounces the right, during the existence of this agreement, to allow any third party to make use of such streets, &c., for laying down leads for the conduction of electric energy for the distribution of light and power, or for the conveyance of any other illuminant, or to make use of such a right themselves.

The community of Turn commits to the above undertaking, for the duration of the concession, the exclusive lighting of the streets, lanes and open spaces, and pay for this lighting by means of 55 glow lamps, at 25 normal candles each, during 250 nights, for 5 hours' burning, a yearly contribution of 1,375 florins.

The administration of the Clary estates is bound to supply the parish of Turn with electric light for its buildings and institutions, on the following conditions:—

(*a*) The community of Turn has to pay monthly the following fundamental tax: for every glow lamp at 10 normal candles, ½ florin; if at 25 to 32 normal candles, 55 kreuzers; if from 50 to 100 candles, 60 kreuzers, and for an arc lamp, ½ florin (50 kreuzers) per ampère. A reduction will be conceded in the case of lamps connected to an electric meter of 15 per cent. for lamps burning above 600 hours; 30 per cent. for more than 700 hours; 50 per cent. for 800 hours; 65 per cent for 900 hours; 80 per cent. for 1,000 hours, and 100 per cent. (?) for 1,100 hours and upwards.

(*b*) As regards the price for lighting, the parish of Turn has to pay for every burning-hour, per glow-lamp of 10 candle-power, 1·8 kreuzers; of 16 candles, 2·3; of 25, 3·8; of 30, 5 kreuzers; of 50, 8 kreuzers; for an arc lamp at 6 ampères, 18 kreuzers; and at 8 ampères, 27 kreuzers.

(*c*) The current supplied will be measured by meters, for which a charge will be made of 10 florins up to 10 instruments, of 16 florins up to 25, of 20 up to 30, of 25 florins up to 100, &c.

(*d*) At the above-mentioned prices the Inspection Board of the Clary estates allows the community of Turn a discount of 10 per cent.

The said Inspection Board reserves the power of making agreements with the inhabitants of Turn for the supply of electric current, and fixing prices which may admit of the greatest possible consumption of current by private persons. The prices fixed for private consumers, however, must not be lower than those fixed for the community. Otherwise the community has the right to demand its supply at the lowest rate fixed for private consumers.

Until the central station is set at work, and whilst the leads required by the community for its buildings, &c., are being laid down, leads for private consumers will be laid down up to the front of the house without any extra charge. After this time connections from the nearest point of the main cable will be made at the cost of the applicant. This stipulation does not apply to public lighting.

On the conclusion of the agreement the community of Turn will be supplied with a plan of the situation of the central station, and of the projected conductive net for the supplying the current.

The installations, *i.e.*, the fitting up and repairing the leads and other fittings in the interior of houses must be executed exclusively by the central station on a scale of prices which is to be agreed on yearly with the community. Such fittings as lamps, chandeliers, brackets, &c., are not included in the installation. The prices in the scale just mentioned must be neither higher nor lower than those which the city of Vienna pays at any time to the International Company or other works there, but with the addition of 10 per cent. This tariff includes the prices for street cables, electric meters, the fittings of glow and arc lamps, and the carbons which will be supplied from the central station. These glow lamps will be supplied for a monthly rent of ¼ florin each, which includes the gratis replacement of lamps which have been worn out. Tne fittings for public buildings may be obtained from any source, but Prince Clary's estate Inspection Board has of testing if the conducting wires are suitable and if the the right lamps are properly connected.

All damage to the streets and pavements occasioned in laying down the leads, &c., are to be made good by the central station without delay. If it does not at once comply with the request of the community in this respect, such repairs may be at once executed by the community at the cost of the central station.

The central station can never be held responsible for interruptions in the supply of current due to war, rebellion, strikes, or natural calamities, such as floods or conflagrations, or to the malice of third parties, or which may arise from unforeseen defects in the machinery. But in these cases the Estate Inspection Board is at once to give notice to the community.

Penalties are imposed for any non-observance of the duties imposed upon the Estates Inspection.

Disputes arising from this agreement are to be decided by expert arbitrators, who must not be in a position to be influenced by either party. Each party has to appoint an expert arbitrator, and these arbitrators select an umpire.

No legal appeal may be taken against the decision. The Estate Inspection Board has not the power to cut off the current entirely, or partially during any dispute.

The agreement is to last for 25 years, counting from the day when the installation is set in action. The prices fixed as above are to hold good for 10 years only. Three months before the expiry of these ten years a new agreement as to prices must be come to by the contracting parties for the next ten years, and after the lapse of this second five years the prices for the remaining 5 years must be arranged.

If the Clary Estates Inspection Board does not begin the construction of the central station within six months from the day of signature of this agreement, the latter becomes null and void.

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Mr. T. M. Sweeny thought that in the consideration of the subject before the society the fact is lost sight of that electricity is merely a ready means of transmitting energy instead of a belt or a rope or other methods which have been employed at various times. The remark made by Mr. Scheffler, which was to the effect that, if steam cars were allowed to be run through the streets of cities, they would instantly supplant electric traction, was rather erroneous. That can hardly be possible, because for street traffic a higher class of labour is required to take care of and manage the steam locomotive than to take care of and manage an electric motor, and it is that feature which makes electricity so particularly applicable to street traffic. One can pick up a class of labour and educate it in a short time to handle the electric motor. There is too much disposition on the part of mechanical engineers to conclude that a requisite for electrical application is a lack of mechanical engineering knowledge. For a time, Mr. Sweeny was of that opinion, and thought that it would be but little trouble to correct many of the weak places in mechanical details, but he has generally found that they are too closely allied with the electrical question, and that what would certainly be a successful device if electricity was left out of the question, became anything else when connected with the electrical end. There is a great field for mechanical engineers in working out the details of the adaptation of electricity. But, in order to be successful, the engineer must also know a great deal of the properties of electricity.

THE ACTION OF ELECTRICITY ON MICROBES.

ELECTRICITY appears to be a determined enemy to microbes. The first researches concerning the action of electricity on microbes were carried out by M. Schiel, and go back to 1875. Observing that under the influence of the electric current certain mobile bacteria ceased to move, the author therefrom concluded that the electricity had killed them; but it is now known that immobile microbes are not dead microbes. Thus MM. Cohn and Benno-Mendelsohn again took up these researches, bringing thereto this corrective, that the microbes were not considered as dead only so far as their sowing was sterile. The experimental process employed by these gentlemen specially consisted in passing through a U-tube containing the nutritive solution the current from a few elements of a Marié-Davy pile. The nutritive solution had been sown previously, and when it became thick it was concluded that the current had remained without action.

In thus conducting their experiments, MM. Cohn and Benno-Mendelsohn saw that the effect of a weak momentary current was always *nil*. With a longer and a more intensive action, for instance, with the current from two powerful elements for twenty-four hours, the liquid near the positive pole remained intact, but the bacteria were not killed. It seemed even that this was the liquid which had become sterile, for it did not let a new sowing which had been introduced multiply, and, in reality, it had become strongly acid. With a current from three elements for twenty-four hours, there were at one and the same time observed at the two poles the death of the bacteria and the sterility of the liquid traversed by the current. But as it produced a profound chemical change in the cultivation, it was not possible to draw any conclusion relative to the direct action of electricity on the microbes. The experimenters, in order to avoid these decompositions produced by the current, then tried induction currents, but without obtaining appreciable results. With cultivations on potatoes, the chemical changes also occurred. The recent experiments of MM. Apostoli and Laquerrière, whose experimental preparations were not suffici-

ently described, but who appear also to have used a U-tube, have not advanced the question.

In order to free themselves from these causes of error, MM. Prochownick and Spoeth made use of an ordinary vase in bringing the electrodes together; the currents produced in the liquid by the gaseous emanations, while easily mixing the layers, constantly re-combining the elements dissociated by the current, and thus producing an average and persistent state, the duration of which was of only second importance. The authors, however, in acting by this process on the hay bacillus, the pus micrococus, and the carbuncled bacteriæ, only obtained insignificant results. In short, as M. Duclaux remarks, in all these experiments, if any sensible action has been found, it must be put down as a chemical action, and hitherto no one has been able to place in evidence a physical, direct action of electricity on microbes.

THE ELECTRIC LIGHT AT TURN.

[FROM A CORRESPONDENT]

THE community of Turn, in Bohemia (not far from the watering place Teplitz), in a municipal meeting held on December 17th, 1890, resolved on the introduction of the electric light, and for this purpose concluded an agreement with the Board of Inspection of Prince Clary's estates. The latter body stipulates to begin the erection of the electric central station within six months at the latest.

The community of Turn is certainly only a small town, as appears from the circumstance that for the public lighting of the streets, lanes, and open spaces only 55 glow lamps are projected, each of 55 normal candle-power, which are to burn for 5 hours during 250 evenings yearly. But Turn is a rising community with a prosperous industry, and as the projected electrical works are also to furnish current for the production of motive power, all the conditions for a lucrative development are present.

The agreement is made very favourable for the party supplying the current, and it contains some noteworthy stipulations, providing for an interruption of the work by external interference, such as, *e.g.*, the outbreak of a strike.

The most important stipulations are the following;—The community of Turn concedes to the Inspection Board of Prince Clary's estates the right to utilise the streets, lanes, and open spaces within the parish of Turn (in as far as it possesses the right of disposing of them) for laying down leads for conveying electric energy, whether above or underground, for the purposes of lighting, and for the transfer of power.

The community of Turn renounces the right, during the existence of this agreement, to allow any third party to make use of such streets, &c., for laying down leads for the conduction of electric energy for the distribution of light and power, or for the conveyance of any other illuminant, or to make use of such a right themselves.

The community of Turn commits to the above undertaking, for the duration of the concession, the exclusive lighting of the streets, lanes and open spaces, and pay for this lighting by means of 55 glow lamps, at 25 normal candles each, during 250 nights, for 5 hours' burning, a yearly contribution of 1,375 florins.

The administration of the Clary estates is bound to supply the parish of Turn with electric light for its buildings and institutions, on the following conditions:—

(*a*) The community of Turn has to pay monthly the following fundamental tax: for every glow lamp at 10 normal candles, ½ florin; if at 25 to 32 normal candles, 55 kreuzers; if from 50 to 100 candles, 60 kreuzers, and for an arc lamp, ½ florin (50 kreuzers) per ampère. A reduction will be conceded in the case of lamps connected to an electric meter of 15 per cent. for lamps burning above 600 hours; 30 per cent. for more than 700 hours; 50 per cent. for 800 hours; 65 per cent for 900 hours; 80 per cent. for 1,000 hours, and 100 per cent. (?) for 1,100 hours and upwards.

(*b*) As regards the price for lighting, the parish of Turn has to pay for every burning-hour, per glow-lamp of 10 candle-power, 1·8 kreuzers; of 16 candles, 2·3; of 25, 3·8; of 30, 5 kreuzers; of 50, 8 kreuzers; for an arc lamp at 6 ampères, 18 kreuzers; and at 8 ampères, 27 kreuzers.

(*c*) The current supplied will be measured by meters, for which a charge will be made of 10 florins up to 10 instruments, of 16 florins up to 25, of 20 up to 30, of 25 florins up to 100, &c.

(*d*) At the above-mentioned prices the Inspection Board of the Clary estates allows the community of Turn a discount of 10 per cent.

The said Inspection Board reserves the power of making agreements with the inhabitants of Turn for the supply of electric current, and fixing prices which may admit of the greatest possible consumption of current by private persons. The prices fixed for private consumers, however, must not be lower than those fixed for the community. Otherwise the community has the right to demand its supply at the lowest rate fixed for private consumers.

Until the central station is set at work, and whilst the leads required by the community for its buildings, &c., are being laid down, leads for private consumers will be laid down up to the front of the house without any extra charge. After this time connections from the nearest point of the main cable will be made at the cost of the applicant. This stipulation does not apply to public lighting.

On the conclusion of the agreement the community of Turn will be supplied with a plan of the situation of the central station, and of the projected conductive net for the supplying the current.

The installations, *i.e.*, the fitting up and repairing the leads and other fittings in the interior of houses must be executed exclusively by the central station on a scale of prices which is to be agreed on yearly with the community. Such fittings as lamps, chandeliers, brackets, &c., are not included in the installation. The prices in the scale just mentioned must be neither higher nor lower than those which the city of Vienna pays at any time to the International Company or other works there, but with the addition of 10 per cent. This tariff includes the prices for street cables, electric meters, the fittings of glow and arc lamps, and the carbons which will be supplied from the central station. These glow lamps will be supplied for a monthly rent of ¼ florin each, which includes the gratis replacement of lamps which have been worn out. Tne fittings for public buildings may be obtained from any source, but Prince Clary's estate Inspection Board has of testing if the conducting wires are suitable and if the the right lamps are properly connected.

All damage to the streets and pavements occasioned in laying down the leads, &c., are to be made good by the central station without delay. If it does not at once comply with the request of the community in this respect, such repairs may be at once executed by the community at the cost of the central station.

The central station can never be held responsible for interruptions in the supply of current due to war, rebellion, strikes, or natural calamities, such as floods or conflagrations, or to the malice of third parties, or which may arise from unforeseen defects in the machinery. But in these cases the Estate Inspection Board is at once to give notice to the community.

Penalties are imposed for any non-observance of the duties imposed upon the Estates Inspection.

Disputes arising from this agreement are to be decided by expert arbitrators, who must not be in a position to be influenced by either party. Each party has to appoint an expert arbitrator, and these arbitrators select an umpire.

No legal appeal may be taken against the decision. The Estate Inspection Board has not the power to cut off the current entirely, or partially during any dispute.

The agreement is to last for 25 years, counting from the day when the installation is set in action. The prices fixed as above are to hold good for 10 years only. Three months before the expiry of these ten years a new agreement as to prices must be come to by the contracting parties for the next ten years, and after the lapse of this second five years the prices for the remaining 5 years must be arranged.

If the Clary Estates Inspection Board does not begin the construction of the central station within six months from the day of signature of this agreement, the latter becomes null and void.

SOME MEASUREMENTS THAT ARE CONVENIENTLY ACCOMPLISHED IN PRACTICE BY THE WESTON HIGH RESISTANCE VOLTMETER.*

BY OSBORN P. LOOMIS.

IN the following I have attempted to give a practical description of some methods of applying a high resistance voltmeter to the ordinary measurements that occur in the everyday life of the electrical engineer. It is attempted to make them as clear as possible, and probably more so than is necessary to many, who may also have used the same method with various modifications; to others, however, they may prove of interest and value.

The first application I will mention is that of measuring approximately the insulation resistance of line work, &c. In the diagram, fig. 1, is shown a system of wiring in which we

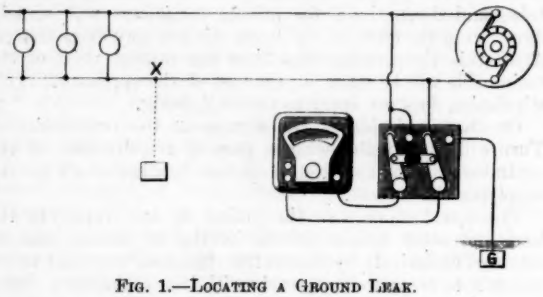

FIG. 1.—LOCATING A GROUND LEAK.

will suppose there is a leak at X. By providing a ground at another suitable place, and attaching the voltmeter as shown, take a reading on the ground circuit, and call it V. Then take the full E.M.F. of the line, calling it V′. Knowing the resistance, R, of the voltmeter, the resistance of X or the ground leak will be $\frac{V' R}{V} - R$.

The following is an example:

Ground reading, 20 volts, V. Line reading, 120 volts, V′. Voltmeter resistance, 16,660 ohms, R.

Applying the formula we get,

$$\frac{120 \times 16{,}660}{20} - 16{,}660 = 99{,}960 - 16{,}660 = 83{,}300 \text{ ohms.}$$

The line insulation resistance is therefore equal to 83,300 ohms.

In this manner insulation resistances may be measured up to one megohm and at any time while the circuits are in operation, the convenient connecting switches being permanently arranged on the switchboard. In this way interesting data can be obtained regarding the effect of different states of weather on the line.

This principle can be applied to the measurement of the resistance of the human body, and it is a much more desirable method than by the Wheatstone bridge. Fig. 2 shows the arrangement in detail.

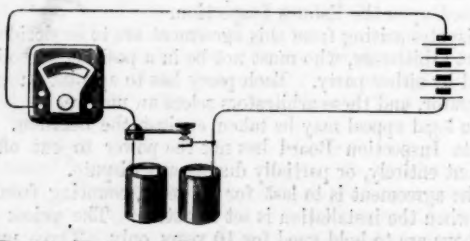

FIG. 2.—MEASURING RESISTANCE OF THE HUMAN BODY.

Two glass jars are provided, each containing a weak solution of caustic potash, and copper plates connected in series with the voltmeter and dynamo, or a battery of small storage cells to be described later. It is desirable to run the voltage up as high as the subject can endure, which may be 140 volts.

* New York *Electrical Engineer*.

Then the jars are short-circuited by the key and another reading is taken. Calling the first reading V and the second reading V′, and the resistance of the voltmeter, R, the result is found as in the previously mentioned insulation resistance, viz: $\frac{V' R}{V} - R$.

Here is an example;

Subject in circuit, 140 volts, V.

Voltmeter alone, 149 volts, V_1; resistance of voltmeter, 16,660 ohms, R.

Applying the formula,

$$\frac{149 \times 16{,}660}{140} - 16{,}660 = 1{,}731 - 1{,}660 = 1{,}071 \text{ ohms.}$$

If the circuit closing key is opened while the subject's hands are in the solution, the sudden shock will be very unpleasant; but by immersing the hands while the current is on it can be endured quite readily, as the volume of current will probably not exceed 9 milliampères with 150 volts on the voltmeter. It is, of course, obvious that a high resistance voltmeter is absolutely necessary in these measurements; in fact, the higher it is, the better.

I will here mention a simply made storage battery for these and other measurements. Procure about 72 large-mouthed bottles, about 2½ inches in diameter and 6 or 8 inches deep. Make the plates of lead strips with other very narrow strips of lead wound around the portion which is immersed in the acid. To save the trouble of numerous connections, make one strip long enough to reach over into both bottles with the afore-mentioned wound portion on each end. The arrangement is shown in fig. 3. They are usually

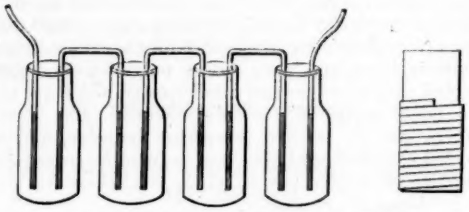

FIG. 3.—SIMPLE STORAGE BATTERY FOR TESTING.

charged in two rows in multiple, as ordinary incandescent circuits do not give the requisite E.M.F. in series. A switch is used, fig 4, which quickly throws them in series and multiple with the discharging circuit. One of the uses of

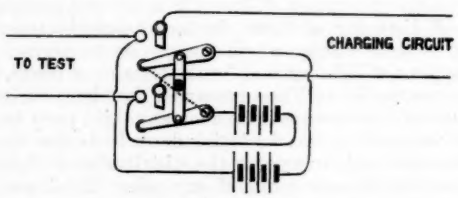

FIG. 4.—CHARGING SWITCH.

this battery is in photometry work; as the current gradually falls, it is started at a higher E.M.F. than the standard, and the screen watched when the balance is obtained; then a signal is given and the E.M.F. and current are read by other parties, so that the efficiency for any given candle-power is obtained.

We now come to the internal resistance of batteries, in which no ammeter is required, but a standard resistance, fig. 5, made of heavy German silver or platinoid wire, about No. 7 or 8 gauge. Ten spirals wound right and left handed and placed alternately, to avoid magnetic effect as far as possible, are arranged to be connected in series or multiple by large brass screws. By this arrangement it can be measured in series or multiple and any error can be found that might exist where only the low resistance could be measured. This resistance is conveniently adjusted to $\frac{1}{100}$ of an ohm in multiple; in series it would be 1 ohm measured in legal units. In this combination a variety of work can be accomplished.

To measure the resistance of an accumulator, connect up as shown in fig. 5. Take a reading of the E.M.F. with the

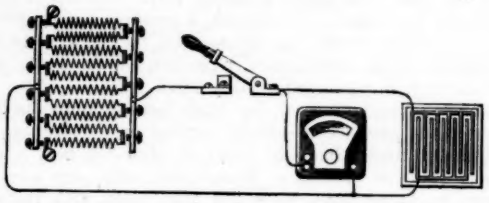

FIG. 5.—MEASURING THE INTERNAL RESISTANCE OF BATTERIES.

cell on open circuit, and call it v; then close the circuit through the standard resistance and call the decreased E.M.F., v′. Then the internal resistance of the accumulator is $\frac{v - v'}{\frac{v'}{\text{Stand. R}}}$

The following is an example:

E.M.F. on open circuit, 2·15 volts; E.M.F., discharging through standard resistance of ·01 ohm, 1·43 volt. Then, by the formula, the internal resistance of the cell is,

$$\frac{2{\cdot}15 - 1{\cdot}43}{\frac{1{\cdot}43}{{\cdot}01}} = \frac{{\cdot}72}{143} = {\cdot}005 \text{ ohm.}$$

In this experiment the connections and conductors must be as large as possible so as to avoid any errors from that source; but they may be obviated entirely by taking the P.D. directly off the terminals of the battery and the terminals of the resistance beyond the point of connection. This is only an application of Ohm's law pure and simple, and it is because of its simplicity that makes it so valuable.

I might mention that in this method it is necessary to have the double-reading voltmeter, but the internal resistance of a group of cells can be found quite readily by the single-reading voltmeter, and then the average resistance, of course, can be found. Say, we have a group of 10 cells and the standard resistance is changed to 1 ohm. If we get 21 volts on an open circuit and, closing the circuit through the resistance, it drops to 20 volts, then the internal resistance of the group of 10 cells will be,

$$\frac{21 - 20}{\frac{20}{1}} = \frac{1}{20} \text{ or, } {\cdot}05 \text{ ohm, total resistance.}$$

Hence, the resistance of 1 cell is $\frac{{\cdot}05}{10} = {\cdot}005$ ohm.

The internal resistance of batteries can also be obtained by the charging current as well as the discharging; for, suppose in charging 25 cells we observe by an ammeter 30 ampères flowing in the circuit and their P.D. is 56·8 volts. Upon taking off the current and observing *the instant* the needle stops falling (the instrument being so "dead beat" that there is very slight oscillation after the current is disconnected), it shows 50 volts; then the internal resistance is,

$$\frac{56{\cdot}8 - 50}{\frac{50}{1}} = \frac{6{\cdot}8}{50} = {\cdot}136 \text{ ohm, total; or } \frac{{\cdot}136}{25} = {\cdot}005 \text{ ohm per cell.}$$

This method is not as accurate as the preceding one, but can be used in the case of primary batteries which polarise rapidly on a discharge.

The next application is to the measurement of low resistances by the low-reading scale of the voltmeter, such as armatures and series-coils of compound dynamo machines. As shown in fig. 6, put the standard resistance of ·01 ohm in series with the armature, series-coil and an accumulator, or, better, several accumulators in parallel. Take the P.D. of the standard resistance and call it v; then the P.D. of the armature, calling it v′. The resistance of the armature will be

$$\frac{v' \text{ (Stand. R.)}}{v}$$

Example:

P.D. at Stand. R. = 2·35 v., v; P.D. armature = 3·15 v., v′.

Applying the formula,

$$\frac{3{\cdot}15 \times {\cdot}01}{2{\cdot}35} = {\cdot}013 \text{ ohm.}$$

The resistance of the series-coil is found in the same way. To check errors from the diminution of current between readings, they should be gone over twice. This same standard resistance can be used to measure currents of comparatively large magnitude, say, up to 400 ampères. It is best to take the readings as quickly as possible to avoid the temperature error, which, while not large, it is better to avoid as much as possible.

In this measurement the P.D. observed, divided by the standard resistance, equals the current. For example, suppose we obtain the P.D. of 2·55 volts and the standard resistance was ·01 ohm; there would then be 255 ampères flowing in the circuit. I find this very useful in calibrating ammeters, using 6 or 8 cells of accumulators of large type connected two in series and three or four in multiple. In

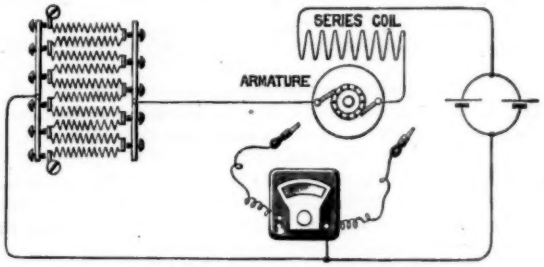

FIG. 6.—MEASURING LOW RESISTANCES.

this way it is possible to obtain 300 ampères long enough to secure a reading. Smaller currents may be obtained by a resistance introduced in the circuit, generally a German silver strip with a heavy sliding contact.

For reading from 1 to 15 ampères, use the coils in the resistance put in series, and the P.D. (if the resistance is 1 ohm) will be in terms of the current. It is seen that quite a range of work can be obtained. Sometimes it is desired to read a higher E.M.F. than the voltmeter is graduated to do. By introducing the resistance, of course, the reading is reduced. Add the resistance of the voltmeter (with which they are all accurately marked) and the reading will be halved. This resistance being so high is the most troublesome to make. A very convenient way is to take a piece of ground glass marked with graphite and measured by the Wheatstone bridge and finally adjusted with the voltmeter.

To verify the reading of the voltmeter at any time, or, in other words, to compare it with a standard cell, take an ordinary resistance box (legal or B.A. ohms), and connected as shown in fig. 7, using two keys (generally those on the

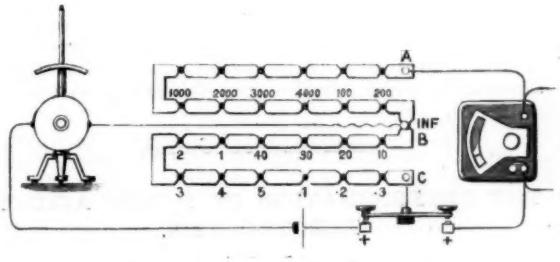

FIG. 7.—CALIBRATING THE VOLTOMETER.

box), the first one to close the circuit through the total resistance from A to C, and the other to close the standard cell through the galvanometer. If we are reading about 100 volts, and unplug 5,000 ohms between A and B, then we unplug enough between B and C to obtain a balance in the standard cell circuit. It is advisable to have the least possible current flow through the standard cell, and at the commencement it is convenient to know approximately what resistance to unplug between B and C so that the balance will

be nearly obtained upon the first trial. For example, suppose we have unplugged 5,000 ohms between A and B and we observe that the E.M.F. to be tested is about 112 volts and the standard cell is 1·444 volt. Multiply the 5,000 by 1·444 and divide the product by 112—1·444; the result will be approximately the number of ohms to unplug from B to C. Thus,

$$\frac{5{,}000 \times 1{\cdot}444}{112 - 1{\cdot}444} = \frac{7{,}220}{110{\cdot}556} = 65{\cdot}3 \text{ ohms.}$$

This is merely to save the trouble of hunting around after a balance, as well as to avoid unnecessary current passing through the standard cell; after this is done, however, we disregard the reading on the voltmeter and fall back on the standard cell E.M.F. as the standard. When this is done, the total E.M.F. will be $\frac{(R + R')\,V}{R'}$,

where R equals the resistance between A and B; R′ the resistance between B and C; and V the E.M.F. of the standard cell.

Example: Resistance unplugged between A and B, 5,000 ohms; resistance unplugged between B and C, 66 ohms.

Applying the formula, $\frac{(5{,}000 + 66)\,1{\cdot}444}{66} = 110{\cdot}7$ volts.

In this method it is necessary to observe the position of the needle very carefully at the instant the balance is obtained, and not observe one and then the other with any large interval of time, for, with a sensitive galvanometer changes of ·1 volt in 100 are easily detected. The connection at I.N.F. is made by a cord and plug, the plug being made to fit the holes which are on the box. By this means this contact can be made at any point desired.

I will add to this article some points of interest to operators generally, as they may obviate some of the troubles that have come to others. This instrument, sensitive as it is to $\frac{1}{10}$ of 1 per cent., should receive a corresponding amount of good usage. No one would think of slamming a good watch around; yet the jewels and pivots of these instruments are as carefully made and adjusted as in a fine watch.

Being affected by magnetism, close proximity to all powerful magnetic fields should be avoided. Of course a nice voltmeter looks neat on a switch-board, but, surrounded by bus bars carrying heavy currents, that is far from the best place for it. It is better to put it in a place by itself at least 12 feet away from the conductors and dynamo, in fact, the further, the better, to secure accurate results. As only small wires are necessary to connect with the mains the above arrangement will cause little inconvenience. Of course it is unnecessary to state that it should never be carried near a dynamo, much less laid on the top of one, while in operation.

I will also call attention to the low temperature error that exists with this instrument. There being no copper wire of any consequence in the circuit, the current is so very small on account of its high resistance, that it can be left on the circuit indefinitely; it can also be used in the ordinary differences of surrounding temperature, with only an error of a fraction of 1 per cent. I will state that some of these instruments, after having been in use for three years, have been calibrated, and agreed perfectly with the original, showing that, when handled properly, their permanency is unaffected.

THE DETERMINATION OF NITRIC ACID BY ELECTROLYSIS.

WHEN solutions of nitrates are acted upon electrolytically, the nitric acid which they contain in a combined state is reduced to ammonia. It has recently occurred to a German chemist, G. Volkmann, to make use of this observation and to determine the conditions under which this electrolytic decomposition or transformation is best effected. The investigation has been so far successful that it has resulted in the discovery of a quantitative method by means of which nitric acid may be conveniently estimated.

Volkmann's work may be consulted *in extenso* in the current issue of the *Berichte de Deutschen Chemischen Gesellschaft* (Vol. xxiii., p. 2,798—2,801). Briefly we may thus describe it:—

On passing a galvanic current through dilute acid or through a solution of the nitrate of an alkali (*e.g.* $K NO_3$) that has been previously acidified with sulphuric acid, no ammonia is formed; if, however, a metallic salt be present whose acidified solution is decomposed by the current with deposition of the metal, then reduction of the nitric acid, whether free or combined, readily takes place.

Complete reduction of the nitric acid to ammonia takes place in the presence of salts of mercury or of platinum, but Volkmann finds that the result is obtained best when a copper salt is present. When zinc salts are used the reduction to ammonia does not take place with the same degree of certainty.

The essential features of this method of determining nitric acid are as follows:—A sufficient quantity of pure copper sulphate is added to a solution of the nitrate contained in a platinum dish, and the mixture after being acidified with sulphuric acid is electrolysed. As soon as all the copper is deposited the solution is evaporated to a small bulk and the ammonia is distilled as usual.

The strength of current used in this operation is one that would yield from 1·0 to 2·0 cc. of electrolytic gas (oxygen and hydrogen) per minute.

The amount of copper sulphate used is guided by the approximate amount of nitric acid present in the salt that is to be analysed. For instance suppose it were required to determine the nitric acid in potassium nitrate, it would be necessary to take half as much crystallised copper sulphate; if less be used the rate of deposition must not be so fast.

The following experiment is described as illustrating a modification of the above method which may be used in cases when a neutral salt is under consideration, or when other salts are present, which undergo no permanent decomposition: To a solution of potassium nitrate dissolved in water is added a measured quantity of sulphuric acid containing a known strength of acid. The positive electrode is coppered and the current of electricity is then passed until all the copper has been transferred to the negative electrode. The excess of sulphuric acid is then determined by titration against an alkali, but in this particular instance it must be noticed that some of the titrated acid is taken up by the potassium. This is expressed in the equation

$$KNO_3 + 4\,H_2 + H_2SO_4 = K(NH_4)SO_4 + 3\,H_2O$$

This of course must be taken into account in the calculation.

Volkmann states that the method is delicate, rapid and reliable, it is without doubt extremely interesting and might with advantage be added to the laboratory notebooks of our readers.

IS SCIENCE DISCIPLINED KNOWLEDGE, OR IS IT SOMETHING ELSE?

BY S. ALFRED VARLEY.

(*Concluded from page* 6.)

PROF. HERTZ'S experiments, interesting as they are, do not seem to bear very directly on practical electro-dynamics, and it is not proposed to discuss them in this communication; but the writer must be allowed to say that he claims to have shown in previous communications that the experimental demonstrations of Prof. Lodge, in connection with the Dr. Mann lectures, even if they stood alone by themselves, disprove the mathematical elucidations of Maxwell's theory, so far as the passage of transient currents are concerned. It is further claimed that the electrical welding experiments performed at the Institution of Civil Engineers do not in any way go to support the confidently expressed statements of Sir William Thomson as to the behaviour of transient currents, and further, it is contended that what was observed during the the time the welding experiments were being performed, was directly opposed to that which Sir William Thomson, in his Edinburgh paper of 1890, referred to as "the known laws of the diffusion of electric currents through non-magnetic conductors, considered in connection with the

magnetic susceptibility of unknown amount and laws in conductors of steel and iron."*

Practical men will, it is thought, unhesitatingly place more reliance upon the electric welding experiments lasting over a week, and during the course of which iron bars of more than an inch in diameter were heated by electric alternations of some thousand of ampères, than on a single *accidental* experiment, in which a continuous current dynamo circuit of 83 ampères and 103 volts, was momentarily short-circuited by a steel bar held in the hand. Moreover, this accidental experiment was not performed by Sir William Thomson himself, but simply reported to him; nevertheless it was made the subject of a scientific paper, and put forward as convincing evidence of the truth of theory. What has just been said has been threshed out in previous communication, but Sir William Thomson, having ignored all that has been brought forward by the writer in opposition to the newer theory, it has been thought advisable to reiterate certain of the main points, and the more so because there is reason to believe that the most will be made of Prof. Hertz's experiments by certain of our physicists, who would seem to be really more anxious to assert the infallibility of scientific orthodoxy than to propagate scientific truth.

When striving to solve scientific problems it has become in the writer's own case almost an instinct, first, to reduce the subject he is dealing with to its component elements, and then from these elements to build up a structure, brick by brick, and to buttress it up by studying at the same time other branches of science. By adopting the course described, seeing the physical sciences are all of them related, incorrect reasoning is often quickly corrected, the direction in which truth lies sometimes indicated, and experimental research very much simplified. It is within the writer's experience that scientific edifices reared in the manner described are not easily toppled over, and it is thought that the communications in opposition to the newer theory which have appeared in this journal may be cited as exemplifying what has just been said. On the one hand, a good many encouraging communications, altogether, have been received by the writer; but, on the other hand, no physicist seems disposed to challenge the views developed in the writer's communica-tions.

The issues championed by Prof. Lodge and Sir William Thomson, it is contended, have been criticised in a non-partisan spirit, but the writer has not succeeded in obtaining any frank answers to his frankly-put questions. Sir William Thomson himself has maintained silence. Such silence may be masterly, but it is scarcely philosophy in the sense of the term, and it may be certainly claimed by the writer as negative evidence that the position he has taken up in connection with Maxwell's electrical theory during the last three years is felt to be unassailable.

The basis on which Maxwell's theory rests, is the theory which assumes all space to be permeated with a medium termed the ether jelly, Sir William Thomson has popularly described this hypothetical jelly as possessing in an almost inconceivably refined degree the properties of a jelly—viz., elasticity with an absence of fluidity, and that also of pitch, viz., inelasticity and fluidity. To minds so constituted as to experience no difficulty in mentally conceiving a hypothetical medium such as that physicists assume to fill all space, the ether theory is an ideal one for the imagination to conjure with, for it assumes, in effect, the existence of a something possessing at one and the same time properties and no properties. As a matter of fact, the physicist assumes (1) that the ether jelly has properties common to matter without being matter, for it possesses no weight; (2) it is supposed to be an oscillatory mediam, this involves its possessing inertia a convertible term for weight, seeing that the weight of any medium is the measure of its inertia; (3) the ether is assumed to behave as a perfect fluid, being at the same time a jelly, the distinguishing characteristic of which is an absence of fluidity.

The writer always regards the ether theory as the scientist's Athanasian creed, for it is quite as difficult to reconcile with common sense reasoning. As an illustration of the way the ether jelly is assumed to behave, place under the receiver of an air pump a thin metal bottle, having flat sides and a light valve closing the mouth, but opening freely outwards. Now exhaust the air in the bottle and the receiver by pumping, the air will be removed, but not the ether, for it is a solid inexpansible jelly, which is incapable of being pumped out, but if the air now be let in, the mouth of the bottle becomes closed by the valve, the metal sides of the bottle collapse, and are forced into contact with one another by atmospheric pressure, the ether jelly conveniently behaving as a perfect fluid, and passing through the solid metal without hindrance.

Common sense refuses absolutely to believe in the *actual* existence of a medium such as the ether theory demands, but many of our physicists would appear to have no difficulty in doing so; they accept it as an act of faith on scientific authority, and expressed as a symbol it becomes as concrete to mathematicians as matter itself.

Now, it is not contended that the ether theory can be dispensed with; all research seems to suggest that the transmission of energy involves a medium, but the fact that it is found necessary to assume the existence of a medium conveniently possessing positive and negative properties accordingly as they are required, and of whose existence there is no real evidence whatever, demonstrates simply the feebleness of the human intellect relatively to the mysteries we move among, and which an almost irresistible instinct impels us to try and grapple with.

It is most fallacious to argue that, because a theory has no rival it is necessarily true, and yet this is what our scientists so frequently do—as an example Sir Charles Lyell, in his "Antiquity of Man," says "Darwin's theory has no rival, and not to accept it must be considered an avowal that the question lies out of the domain of science!—just so, it does lie out of the domain of human intelligence to propound a true theory of creation, as it lies out of the domain of a Roman Pontif assisted by an ecumenical council to propound absolute truths. As a matter of fact, the ether theory does stand upon a very similar footing to that of a Roman Catholic dogma, and the theory on one occasion was brought very vividly before the mind of the writer in a Roman Catholic church. The priest, during his sermon, described the details of the resurrection with all the minuteness and precision of a physicist telling us that our Saviour ascended upwards and passed through the solid rock in the same way precisely as physicists tell us matter and the ether jelly pass through one another, he then said you will ask me how we know? and his answer was simplicity itself—"The Church tells us so, and we are bound to believe it."

The writer has been waking up to the fact now for some time, that there is only too much in common between the methods of our modern schools of science and the most retrograde of the Christian sects; they both of them accept dogmas as acts of faith, and they reverence as authoritative and infallible what has been propounded by mere human intelligence. The following is a condensed extract from a speech delivered by a scientific preacher at the Institution of Civil Engineers: "When so great an authority as Sir William Thomson has told us that transient electrical currents are entirely confined to the outer skin of a conductor, who can doubt it?"

The keystone of the unsoundness, and, it is contended, the growing unsoundness of modern science, is the reverence now paid to the mental assumptions of those who, having orthodox scientific credentials, assert the right to speak authoritatively, and who are considered to do so by the rank and file who sit at their feet. Scientific Popes are no more infallible than theological ones, and both scientific as well as theological popery have risen into power very similarly.

The two greatest educational and social forces, the ones

* It seems to be inferred in the extract given that conductors are divisible into two classes, the non-magnetic, and the magnetic, and that the same laws do not apply to both, the writer is of opinion that the only difference between conductors is one of degree. When an electric circuit is closed through copper, inertia has to be overcome similarly as when a circuit is closed through steel or iron, but in the latter case the inertia opposed is very much greater, and this is the only difference. It has been pointed out in previous communications that magnetism is energy statically occluded (in the case of copper conductors) only so long as the circuit remains closed, but that in the case of magnetic conductors there is a more or less stable association of energy with the conductor, and therefore when an iron or steel circuit is opened the statically occluded energy is parted comparatively slowly and *never* wholly. In a tempered steel magnet the energy is fairly stably associated with it, but not chemically combined. Magnetism being energy, it can exert influence through space, but being combined with matter it cannot do work, its influence through space being negative, not positive, and it strives to maintain the *status quo* in space, and resists the motion of matter through it; in other words opposes inertia to the motion of matter through space.

which have contributed in a greater degree than any others to human progress, are Christianity and the development of the physical sciences.

In the earlier days of the Christian era, men fought against heathen tyranny and bigotry, and as they became victorious, the parasitical growth popery developed itself, and so soon as it became powerful enough to do so, it ruled despotically. At a later date scientific workers pursued science under difficulties, and waged war with theological bigotry. It is not so long ago that Hutton was looked askance upon by respectable orthodoxy for daring to say that a careful examination of the rocks had led him to the conclusions that there were to be seen neither signs of a beginning, nor signs of an ending, and yet those who tabooed him were in the habit of standing up in churches and chapels to declare, As it was in the beginning, is now, and ever shall be, world without end.

There are some of us who can remember the time when science was frowned upon, and we felt very bitter with theological bigotry; but we have lived to see science victorious all along the line, and Darwin himself accorded funeral honours in the Abbey. Victorious science seems to have found its Capua. History would seem to be repeating itself; the era of scientific Popery has fairly commenced, and independent scientific workers are at the present time looked askance upon and tabooed. Every physicist having mathematical credentials now considers himself an electrical authority, and we have more than one great electrician who has never made a single scientific diecovery much less an electrical advance of any kind.

Scientific honours are seldom awarded to scientific pioneers and discoverers; as a rule they are given to intelligent workers who investigate by technical methods the discoveries of others with the aid of instruments of research, to the design of which mathematicians have contributed but little.

Now, not only have our scientific Popes ridden into influence and affluence on similar lines to their theological predecessors, but their methods being only too much alike, the outcome of their respective schools is practically the same also. The one, as we know, has led to indifferentism and atheism in those countries which have been subjected to its rule, and the other leads to a cultured unbelief or refined atheism, to describe which a special word has been coined by a master of style, so as not to offend the over-sensitive.

A great gulf will be found to separate the modern schools of science from that healthier one to which men such as Sir Isaac Newton, Davy, and Faraday belonged, and it is not without significance that the greatest discoveries and the soundest scientific work have originated from, and been developed by, men who were not agnostics. Darwin himself cannot be fairly claimed as an exception to what has just been said, for in his autobiography he tells us he wavered, and he was great enough to recognise that certain of his faculties (the emotional ones) had been starved and damaged by a too great concentration of his vital energies to specialistic studies. He says of himself that his mind seemed to have become a sort of machine for developing general laws out of a large accumulation of facts, and that, could he have lived his life again, that he would have devoted a certain amount of time daily to listening to music and reading poetry. All scientists would do well to ponder over and take to heart the words of Darwin, for the range and nature of his work was certainly wider than that of many of our physicists.

All sound science will be found to rest ultimately on revelation. Man knows nothing excepting that which is revealed to him by observing, and what he observes may be truly described as the dogmatic utterances of Nature—Nature's utterances and those of infallible Popes, be they thelogical, or be they scientific, differ from one another in the fact that the former are as sound and reliable as the latter are unsound and misleading.

It is to men who, like Faraday, Davy, and Newton, sit at the feet of Nature and who ask reverentially to be taught, that Nature reveals in a larger degree her secrets; men such as these have parts in common with our poet philosopher, and discover for themselves there are tongues in trees, they read sermons in stones, find books in streams of running water, and can see good in all things.

No hard and fast lines divide the physical seiences from theology, and were it not that it would be somewhat out of place in a technical journal, the writer would have liked to interpolate a few remarks bearing on their relationship to one another, but whilst refraining from doing so, he must be allowed to say that, in his opinion, spiritual revelations are in every respect as true as physical ones, and, further, that he himself considers man's spiritual knowledge to be in advance of his knowledge of physics, and for the reason not only that theology regarded as a science is very much older than any physical sciences, but because men, *as a whole*, in all ages have been very much more in earnest in its pursuit, recognising as man does intuitively that his relationship to a divine principle is the distinguishing feature of man, and the one, as well as the only attribute he possesses which separates him at all widely from his four-footed brother mamalia.

The present generation of men have been reaping a very abundant harvest from the scientific work of their predecessors. In the earlier portion of the present century scientists were largely composed of amateurs who had no ulterior object beyond making scientific discoveries, and the labours of such men have contributed largely to all that is sound in modern science; but a certain slovenliness, by no means confined to science, characterised the beginning of the 19th century and the earlier half of it. Faraday, the Keble of science, set himself to reform the slovenliness only too common with scientific exposition and research, and, like Keble himself, he unwittingly helped to prepare the way for sensationalism and what, in the absence of a better word, may be called ritualism.

Since the days of Faraday scientific lectures have become works of art and dramatic performances—spectacular effect and vestments receiving more attention from the lecturer than the exposition of new truths.

Prof. Huxley, in his retiring address to the Royal Society, stated "that nothing is of more importance to the man of science than that he should appreciate the value of style," he remarks, "*le style est l'homme même*," as a man of science who was a master of style has profoundly said, and he goes on to say, "a good style is the vivid expression of clear reasoning." Now, there can be no manner of doubt that the vivid expression of clear reasoning is good style, and logically the converse must be equally true, but in practice the stock in trade of the man of style consists of clever word painting and the cultivation of the ability to construct neatly turned meaningless phrases which sound smoothly to the ear, such phrases which really convey no information, whatever, are made only too often to do duty for reasoning as well as to mask and cover up what the science expositor should fairly face, and frankly acknowledge that he cannot explain. In reference to certain of our popular lecturers, the writer once heard some very pertinent remarks made by a scientific enthusiast, a lady scientist, to whom it used to seem to the writer that nature had been kind in every way, and whose countenance, when excited, used to light up, and fairly beam with what can only be described as intellectual enthusiasm; this lady said that she was in the habit of attending *every* lecture delivered at the Royal Institution, and that she made notes, that there were certain of the lectures which fairly carried her away at the time of their delivery, and that there were others very tedious to set out; but when she got home, she very frequently discovered she had learned absolutely nothing from those lectures which were so delightful to listen to; whereas, on the other hand, she found very often that she had carried away from the tedious lectures some new facts and ideas to think upon. Now it is almost needless to say that the charming uninstructive lectures which this lady was referring to, were those delivered by scientists who cultivated and attached importance to style.

Prof. Tyndall, on one occasion, let the public have a peep behind the scenes. Replying at a public dinner given in honour of Henry Irving to the toast of science, he claimed brotherhood with professional actors, on the ground that scientific lecturers and dramatic performers produced their effects by similar means.

Since the days when Prof. Tyndall used to devote himself to providing amusement adulterated with instruction, the world has not been standing still, and the Admirable Crighton, whom learned scientific societies so delight to honour, has succeeded in connecting the Royal Society with legerdemain. At a *conversatione* given the last year by a Government scientific department, the sensation of the evening was what was exhibited and published to the world as a most marvellous scientific advance, was really of the nature of an Egyptian Hall illusion.

But, to return to the Maxwell electrical theory, which has mainly led to this communication, for lightning discharges to be oscillatory there must exist the conditions which oscillation involve, and it cannot be demonstrated that these conditions exist. The conditions which oscillation involve are well understood, and they have been dealt with at length in previous communications. The only oscillations of which there exists any real evidence involve matter the only entity known which possesses inertia.

Inertia (the distinguishing feature of matter) contrasts with and forms a sort of duality with energy. Inertia strives to maintain the *status quo*—energy endeavours to bring about a change. Energy is positive and inertia is negative. In the simple theory developed by the writer, and published in this journal* inertia has been described as negative energy, for all physical acts involve an overcoming of the inertia, or, as the writer would put it, a combination occurs between positive and negative energy.

The existence of a medium filling all space is purely an assumption, there being no evidence of its actual existence. It may, perhaps,, be urged that we do not know what either energy or electricity are, but we have at least evidence of the existence of these two entities, and our knowledge of the laws governing their behaviour is very considerable. It is quite true we cannot say what the entities energy and electricity really are, but we can make a shrewd guess as to what they are not.

If motion be imparted to a billiard ball, and this ball meets in its path a second one, the energy associated with No. 1 ball is tranferred to No. 2 ball, which becomes set into motion, No. 1 ball passing at once from a condition of motion to that of rest, and No. 2 ball will continue to move until the energy transferred to it has been parted with, and the energy it has acquired can *only* be parted with by being transferred elsewhere, either directly to matter or through the medium of what is termed work; and it should be noted that *all* work *involves* matter. Now, what has just been stated if it stood alone would suggest that energy associated with matter cannot leave it excepting by being passed on to some other vehicle, such vehicle possessing certain of the properties associated with matter, and thus the mind feels the necessity of assuming a medium through which the energy radiating from the sun is transmitted.

Physicists who accept Maxwell's theory tell us that light and electricity travel at the same rate; do they wish us to understand by this that if thunder clouds were 192,000 miles distant, a lightning discharge would, like light, reach the earth one second after it had left the clouds? Wheatstone's mirror experiments demonstrate as clearly as experiment is capable of demonstrating anything, that a Leyden jar discharge really consists of two sparks commencing at one and the same moment from the oppositely-charged coatings, and meeting one another midway.

The writer has pointed out in previous communications (developing, at the same time, reasons) that the rate at which a Leyden jar discharge is determined solely by the conditions prevailing in the path of discharge, and that there is no fixed rate, the speed of discharge ranging, theoretically, from the infinitely great to the infinitely slow.

The main burden of the writer's song in all his communications has been continuity between all physical phenomena, and that being so, he would be the last to deny that there is a connection between light and electrical phenomena, and he proposes to point out what he himself conceives to be the connection between light phenomena and electrical phenomena, but as he is anxious to conclude this article, and not to run into another communication, he must express himself, for the sake of brevity, somewhat dogmatically; at the same time, he is prepared to give reasons if called upon.

1. The bond of connection between light phenomena and electrical phenomena is energy.

2. Energy is not light any more than electricity is energy.

3. Light results from energy acting upon matter, and therefore light may be popularly considered a product of energy and matter.

4. Electricity is not energy, but an attribute of matter, and is concerned in the atomic constitution of the molecules of matter, and, speaking popularly, electricity may be described as the door through which energy enters and passes through matter when energy is being transmitted by, say, a dynamo.

5. A Leyden jar discharge through an air space is a transmission of energy through the medium of the electricity of the air path itself, energy *only* and not electricity being transmitted.

6. That similarly as light has been described as being a product of matter and energy, so electrical phenomena may be considered a product of energy and the electricity of matter.

7. No electrical phenomena can be produced in a vacuous space, because where there is no matter there can be no electricity, and similarly light phenomena are not possible in absolute space, seeing that light phenomena involve matter as well as energy.

8. Energy passes freely through space, but it can only do so by passing into some receptacle similarly as already described in the billiard ball illustration, and that being so, energy it is considered cannot radiate from the sun simply into empty space.

9. That magnetism is not electricity; on the contrary, it is energy unstably associated with matter statically.

10. That as magnetism is energy, it is capable of exerting influence through space, but so long as it is statically associated with matter its influence is negatived, and it strives to maintain the *status quo*, resisting the motion of matter within the sphere of its influence, but so soon as energy in the form of magnetism is set free from its unstable association with matter, it at once becomes positive energy, and is capable of performing work.

11. That magnetism (*i.e.*, energy statically and unstably associated with matter) comports itself similarly to the force of gravity.

12. That the magnetic conditon of matter is a sort of connecting link which enables energy, the inertia of matter and the force of gravity to be mentally connected.

In the series of propositions which have now been given the writer has incidentally illustrated his method of research, he has analysed as far as he is at present able the elementary forces concerned in all physical phenomena; by doing so he has obtained a base on which to commence building, and he ventures to think that whereas he, on the one hand, finds it a comparatively easy task to assail Maxwell's theory, and to demonstrate the unsoundness of Prof. Lodge's and also Sir William Thomson's elucidations of it, they, on the other hand, he is of opinion, will find it more difficult to assail what he has brought forward. Now, the writer is contending for a system of research which he regards as the only sound one, so far as breaking fresh ground is concerned. No one will for a moment contend that men trained at colleges, and who, after having distinguished themselves, are endowed as scientific professors, have advantages far greater than, say, the writer, who left school before he was 14, and then spent his youth in a workshop, and yet he is disposed to think that there is no living mathematical physicist in this country who can beat his record for originating practical advances in electrical work. In 1858 and 1859 he showed the practical bearing of theory to submarine telegraphy, bursting up the expensive egg laid by physicists at a cost of upwards of £10,000, and he was complimented by Faraday at the time. He suggested the use of and designed artificial submarine circuits, which have since enabled the longest telegraph cables to be duplexed; he designed and introduced what is admitted to be the greatest improvements in Wheatstone's needle telegraphs; he discovered the dynamo principle, and constructed the first self-exciting dynamo in 1866, and for having done so was awarded the gold medal of the Inventions Exhibition 19 years later. Since then two decisions given in the law courts have established his claim to have introduced the second great advance in dynamo construction.

It would seem that the writer is the only one who has ventured to question, and seriously oppose, Maxwell's theory, if it be the advance forward which physicists declare it is, then Prof. Lodge's claim to be able to see further into the matter than was possible for the greatest men of the past is both logical as well as reasonable.

The advantages possessed by an endowed scientific Professor are necessarily very much greater than those of an outsider like the writer, and that being so, there should be

* See ELECTRICAL REVIEW of March 14th, 1890, article headed Lightning Conductors.

no difficulty in crushingly exposing the errors (if they be errors) of the older electrical school. Our physicists claim to be in possession of clearer lights, and more than one of them have had the advantage of sitting at the feet and being instructed by our greatest living physicist, Sir William Thomson. Is there no one among them possessing faith enough to come forward in the cause of science and break a lance with the writer? If they do not see their way to doing this, surely it is a great satire on the methods of modern physicists and the professorial teachings of the "greater giants" of the present day.

In conclusion, the writer will only add that he would very much like the questions at issue to be submitted to any impartial common sense jury, and one of the questions he would ask them is whether, in their opinion, an earnest student would be likely to obtain more knowledge of electrical phenomena from the joint contributions to the elucidation of the newer theory of Prof. Lodge and Sir William Thomson, than from a perusal of what the writer has published in opposition to it; he, himself, is disposed to think thal the student would find the writings of Thomson and Lodge a mental exercise and very little more, whereas they could not possibly read the writer's contributions without obtaining some knowledge of the laws that govern physical phenomena.

ELECTRIC LIGHTING IN THE CITY.

WE take the following from the *Financial News*:—

"The importance of this undertaking can hardly be overestimated, and its prospects are promising in the highest degree. The district is of the class that experience has proved to be most profitable of all in the enterprise of electric lighting, consisting of large business premises, public offices, and such-like buildings. The eastern division contains several important railway termini, in which arc lights will, no doubt, be adopted—for instance, Cannon Street, Fenchurch Street, Liverpool Street, Broad Street, and Bishopsgate; the central division includes a large number of important warehouses, notably in Fore Street and Wood Street; and the western division, most of the more important newspaper and printing offices. The concessions will eventually be transferred to a limited liability company; or it may be two that will be floated at a favourable turn of the money market. But work is to be commenced immediately, and the two contractors will eventually be in the position, as their custom is, of vending a going concern, retaining a proportion of the shares and the engineering control. Of these financial details, however, nothing can yet be made known, nor, indeed, is anything actually settled. They are in the same hands, both in the interests of the Brush Company and of Laing, Wharton and Down, and are understood to rely on powerful and influential support.

"Consumers will be benefited by the adoption of the sliding scale of the Gas Acts, which will reduce the price of the light, as dividends rise over 10 per cent., and the local authorities have the right to acquire the undertaking, so far as it relates to public lighting, at the end of 21 years, upon the terms fixed by the Electric Lighting Act, and they have also the right to acquire the undertaking, so far as relates to private lighting, at the end of that period, on paying its value as a going concern. They have the right to buy up at the end of 42 years, or at the end of any subsequent 10 years, upon the terms of the Act; but until the undertaking is so purchased, the concession as to private lighting is not determinable, except in the event of certain defaults by the contractors. The contract as to public lighting is determinable by either party at the end of 7, 14, or 21 years. The commissioners have agreed not to consent to any other company obtaining a provisional order during the first 21 years. The work of laying the mains has to be commenced before February 19th, and completed about two years hence. They have to be laid underground, overhead wires being absolutely prohibited. The preliminary work of equipping the central generating stations is already in progress; and it is expected that the first thoroughfare to be illuminated—Queen Victoria Street—will be speedily out of hand. Here, however, there already exists the great convenience of a subway.

"The present public lighting bill of the City is rather less than £10,000 a year. The future cost will be rather more than £20,000. Roughly speaking, gas lamps, of which the probable candle-power is 40,000, are to be replaced by electric lamps of 800,000 candle-power. There are now in each of the three divisions about 1,000 gas lamps. They will be replaced by a gross total of about 400 arc lamps and 1,000 glow lamps. For main thoroughfares arc lamps, costing for maintenance £26 each a year, will be used; and in smaller streets, lanes, and courts, glow lamps, costing each for maintenance £5 or £10 a year. The arc lamps have each a nominal candle-power of 2,000 candles, and they will be placed at intervals of about 250 feet. Midway between two arc lamps, the light will be about 40 times greater than midway between two existing gas lamps of 10 candles each. For private lighting both companies will use the alternating current system; but the pressure will not exceed that of which electrical engineers have had successful experience.

THE CITY AND SOUTH LONDON RAILWAY COMPANY.

THE following list of complaints against this company's method of conducting its traffic appeared in the *Evening News and Post* of Tuesday, under the signature of Thomas Mackenzie-Ledlie, LL.D.:—

"Permit me to call your attention to some of the more glaring defects in connection with the New Underground Electric Railway, lately opened for traffic between London Bridge and Stockwell, with the hope that by ventilating the grievances under which travellers by it suffer, through the medium of your columns, some efforts will be made by the directors to remedy same.

"First. The morning and evening trains are exceedingly badly arranged. They consist merely of three carriages, and are therefore totally inadequate to cope with the rush of passengers coming to and from business. The officials permit the carriages at these periods to be crowded to suffocation. Not only is every seat filled, but there is not even room for passengers to pass out, as the carriages are crowded with people standing. The ventilation at best is excessively poor, but no one can realise the unhealthy, suffocating atmosphere thus produced save those who have had the misfortune to be caged up in such carriages. But bad as affairs are in this respect they are ten times worse in the smoking carriages.

"Second. The lighting of the carriages is the most miserable makeshift I have come across for a very long time. It is practically useless. When the train is stopped at a station the light is all right, and nothing better could be desired, but directly the engine moves and the train goes on its way the light begins to fade away, and e'er we have travelled midway between the stations the carriages are in a state of semi-darkness, if not totally dark. It thus becomes impossible to read, and is practically a nuisance.

"Third. The lifts conveying passengers up and down are not run in any organised manner. In very many cases passengers are kept waiting for the lifts to fill, and are landed down at the rails in just sufficient time to see the train move off; and are therefore provided with the luxury of waiting for another 10 or 15 minutes whilst a train arrives.

"Fourth. The 'officialisms' of the stationmasters, and, indeed, the guards, are at times most tantalising. When (more especially at the termini stations) the passengers are lucky enough to get down in time to reach the train before it goes out, one long continuous bawling to 'hurry up' reaches the ear. Time is just given to make a bolt for the carriages, and scrimmages which would do justice to a football field not infrequently occur.

"Fifth. The arrangements at the turnstiles at London Bridge for taking the fares are far from being as they should. Oft times, when business people are at, say, 5.30 p.m., naturally anxious to get home as speedily as possible, one man will be found only to take the cash, the other turnstile being idle. A crush inevitably occurs, and on this account ladies abandon the line, and the sterner sex also prefer to travel by other routes.

"Sixth. The frequent delays and long stops at times

render travelling a most uncertain matter, especially for those, so to speak, 'bound to time.' I could enlarge on this, but I consider the simple statement enough for my purpose.

"Surely, Sir, the overcrowding could easily be avoided by a better service of cars during the rush at morning and evening time. If no better means can be had for lighting the carriages, then we should have recourse to the oil system, but I have not the slightest doubt that much better arrangements could be made if only the official in charge would travel a little and exert himself. The lifts should be run so as to reach the stations in time to catch the out-going trains. They should be run with more system than they are at present, and the directors should put an end to the howling officialism of their *employés* in the "hurry up" system. If both turnstiles were kept going no crush would occur, and passengers would be enabled to take their seats with leisure and comfort. It may be said that the general public do not feel these grievances, because the number travelling daily is considerable. It is because the system is new and novel that it is supported now; but I much mistake if the directors will meet with the same support in a month's time, unless these matters be at once seen to and remedied."

We can quite understand that the first complaint is well-founded, and the company must have foreseen all that Mr. Mackenzie-Ledlie points out; the defective lighting, also, was known before the opening of the line to the public. The conclusion at which the writer arrives is, we expect, not far from the truth, and it behoves the company to seriously look into these grievances, and make amends for past failings, for competitors with other methods of conveyance will no doubt be keenly alive to any falling off on the electric line, and exaggerate trifling defects into serious blunders. That there are obstacles to be overcome everybody will allow; but only those interested from scientific motives or kindly feelings towards a new departure in locomotion will bear with the company whilst it is groping its way comparatively in the dark to better its service of trains. The general public have but one feeling in the matter, and sentiment for caterers to their wants is unknown to the masses.

Furthermore, there is but little doubt in our minds that another point upon which Mr. Mackenzie-Ledlie does not touch will need revision, and that is the one fixed charge between all stations. People may pay now for the novelty, but soon it will be clearly seen that for intermediate stations at all events another scale of charges must be adopted. Changes, however, even in a well-regulated railway system, take time to produce their effects; therefore Mr. Mackenzie-Ledlie and others like him should not show too much impatience with the operations of an undertaking which has been in actual working existence but a bare month, and which have not yet been rubbed down by the lesson of practical experience to such a degree as to render criticism unnecessary. Probably many of our readers could suggest means to remedy the defects complained of here, and doubtless the company would not hesitate to adopt any reasonable views.

PROGRESS OF THE ELECTRICAL INDUSTRIES.

(*Continued from page* 30).

MESSRS. ARTHUR B. GILL & CO.,

OF 4, Bombay Street, Bermondsey, report to us that they have found 1890 a decidedly busier year than any preceding it. Amongst the more important installations of electric light and power erected by this firm during the past year, may be mentioned a very complete one at the *Sportsman* offices in Fleet Street (where the entire plant of steam engine, dynamo, accumulators, &c., had to be concentrated into a space very limited even for electric light appliances); St. Ermin's Mansions (with a total capacity of nearly 2,000 lights); Marlborough Mansions, and many other residential and business premises in the London district. This year, Messrs. Gill & Co., anticipate a considerable increase of business—tenders for 12,000 being already in hand; whilst a large amount of additional work will accrue from the extensive showroom and stores which they have recently opened at 36, Parliament Street, Westminster, S.W., for the convenience of electrical contractors and the trade generally, as well as for their own clients in the West End.

THE GENERAL ELECTRIC POWER AND TRACTION COMPANY, LIMITED.

About the middle of this year the business of Messrs. M. Immisch & Co., was amalgamated with that of the Electric Traction Company; the two firms now trade under the title of the General Electric Power and Traction Company, Limited.

The new Company have primarily for their main object, electric traction and general power work, but they in nowise confine themselves to these branches, and have during the past year accomplished a considerable amount of lighting and general work.

Their business may roughly be divided into four branches, viz.:—(1) Mining work, (2) tramcar work, (3) electric launch work, (4) general work.

1. *Mining work.*—Work in this department has been exceptionally brisk, and installations have been erected in England, Wales, Scotland, the Continent, Asia, Africa, and Australia. Without going into details, it may be mentioned that almost the whole range of mining work has been successfully accomplished by the "Immisch" plants; winding, hauling, pumping, fan driving, rock drilling, &c., having been carried out in different pits, and in nearly all cases the plants have been arranged on the compound parallel system, so as to be adapted for *both lighting and power*. The aggregate H.P. supplied during 1890 in dynamos and motors for this purpose is very nearly 1,000 H.P.

2. *Tramcar work.*— Although no new lines have been laid down this year by the Company, they have made considerable progress in the general details of accumulator work, and have successfuly run their cars on the North Metropolitan Tramways Company's lines at Barking during the whole of the year. The total mileage for the year is approximately 80,000 car miles. According to schedule time the possible mileage was approximately 1 per cent. more than that actually run. The experience thus gained has enabled the directors to undertake the maintenance of electrically-equipped accumulator car lines at rates which will compare favourably with horses. The company is prepared to treat with tramway companies on these conditions, and have now in course of preparation estimates for several important lines.

3. *Electric launch work*—During the past summer the company had launches both on the Thames, and on the Union Canal at Edinburgh during the late Exhibition. The total number of passengers carried at Edinburgh was 100,000, and the result commercially was thoroughly satisfactory. On the Thames some 12 launches were kept for hire, and although the season was a bad one, yet they were patronised by the public to a large extent. Many important improvements in motors, switches and propellers have been introduced by the company, and in the coming season it is expected that a very considerable increase will be made in the number of boats plying for hire, and consequently in the financial returns of this department.

4. *General work.*—The general work of the company during 1890 was far in excess of that of the previous year and shows a large increase in the demand for motors suitable for central stations, and motors for special machine tools have been in fair demand. A large number of dynamos for electric lighting have also been supplied by the company, and several important installations have been carried out, amongst others, may be mentioned Tatton Hall, Knutsford, the residence of Lord Egerton of Tatton.

The prospect for 1891 is decidedly good, and the company starts the new year with a large number of contracts in hand; several important mining plants are now in course of erection, and others are in negotiation. Electric traction is undoubtedly coming well forward, and the next twelve months will see several schemes brought to a successful issue.

MESSRS. H. F. JOEL & CO.

This firm has been very busy during the year, both in wiring and the manufacture of dynamos, arc lamps, main switches, &c., &c., and has perfected a new type electric motor (Joel's patent) which is said to give a very high efficiency. Several improvements in dynamo machines have been effected. The following are the most important installations carried out last year:— Co-operative Wholesale Society, London, dynamo and complete installation of 200 16-C.P. incandescent lamps; Landport Engine Works, Ports-

mouth, dynamo and complete installation of arc and incandescent lamps; J. Ross, Esq., Highgate (private residence), gas engine, dynamo, accumulators, and complete installation of 50 incandescent lamps; New Drapery Warehouse, Dundas Street, Glasgow, 2 gas engines (Crossley's "Otto") 14 H.P. and 7 H.P., 2 dynamos, accumulators, and complete installation of 400 incandescent and 3 2,000-C.P. arc lamps; W. Brass, Esq., Lancaster Gate (private residence), gas engine (4 H.P. Stockport), dynamo, accumulators, and complete installation of 120 incandescent lamps; Co-operative Society's Provision Warehouse, Leith, gas engine (Crossley's "Otto"), dynamo, accumulators, and complete installation of 250 incandescent lamps; The New Club, Galashiels, gas engine (Crossley's "Otto"), dynamo and complete installation of 50 incandescent lamps; Messrs. Goodacre & Sons, Ceylon Mills, Victoria Docks, dynamo and complete installation of 200 incandescent and 2 arc lamps; Co-operative Stores, Chipping Norton, gas engine (Crossley's "Otto," 6 H.P.), dynamo, accumulators, and complete installation of 60 incandescent lamps; Mr. G. F. Abery, New North Road, Fulham, gas engine, dynamo, and complete installation arc and incandescent lamps; Messrs. J. & W. Rendall, Kingsland Road, N., dynamo and complete installation arc and incandescent lamps.

Wiring only (including switches, fuses, and fittings).—H.M. Public Record Office, 200 lights; L. A. Wallace, Esq., Hyde Park Gardens (house and stables); Dr. Carfrae, Hertford Street; Col. Holled Smith, Victoria Street, S.W.; Col. Webber Smith, Lyric Chambers, Shaftesbury Avenue; The Bank of India, Threadneedle Street; The Bank of Tarajaca and London, Threadneedle Street; Lord Abercrombie, Mount Street, W.; Sir William Holloway, Brighton; E. C. Browning, Esq., First Avenue, Brighton; E. C. Browning, Esq., Onslow Gardens, W.; Mr. Cornock, Western Road, Brighton.

LAURENCE, SCOTT & CO., LIMITED.

We hear that during the past year the business of this company has made considerable strides, and for some months past all the different departments have been overfull of work, necessitating a great deal of overtime to complete the numerous orders in the factory without disappointment to the various customers.

It is well supplied with orders for dynamos and motors, &c., from different parts of the United Kingdom, and abroad, among others nearing completion is a large dynamo to generate 2,500 ampères, to be used in the reduction of aluminium, also a 40 unit continuous current transformer just completed for the Chelsea Electricity Supply Co.; and a large 600 lighter dynamo for Messrs. J. & J. Colman of Norwich.

Within the last few months there has been introduced a specially wound accumulator dynamo, that will charge cells and supply constant E.M.F. to lamp mains, independently and at the same time. The Company has already manufactured and supplied two or three of these machines, and they are working with complete satisfaction. A great demand is anticipated for these.

Messrs. Scott own a patent for a system of underground mains, but as yet have not had an opportunity of laying any length; it is hoped, however, that during the coming year to put them in use in both Norwich and Ipswich, when provisional orders are granted.

During the year lengthy and exhaustive experiments have been made with the Company's patent electricity meter, and it is now brought to such a point that very shortly it will be ready for the market.

The installation department has also been kept fully employed, several installations having been completed in all parts of the country, including business premises, mills, flour mills, breweries, country houses, and private residences and hotels, as well as work emanating from the development of the Central Supply Stations at Norwich and Ipswich, where an increased use of electric motors shows a growing appreciation of their usefulness.

Scott's patent instantaneous fuses have been introduced to no small extent in installation work, and give great satisfaction both to customers and fire insurance companies.

On the whole it is considered the past year has been a favourable one, and as the electrical industry is a fast growing one, the Company hopes in the future to participate still more in the increasing demand for apparatus and work.

MESSRS. NALDER BROS. & CO.

In the year 1890 this firm has experienced a large and increasing volume of business, so much so that it became necessary to remove the business to the central position now occupied at 16, Red Lion Street, Clerkenwell.

In every branch of business they have experienced a share of the prosperity of the times, and to keep pace with the demand have had to carry a much larger stock of both the scientific and the commercial descriptions of instruments. Some very large switchboards have been made and apparatus for central stations. The increased quantity of work and larger premises have necessitated a like increase in the working plant. They have added to their manufactures, Profs. Ayrton and Perry's variable standards of self-induction, and the leakage testing apparatus devised and patented by Mr. Holmes; this instrument is in use in the Liverpool central stations, and will be used also at Birmingham. Here is made Mr. Holmes's battery charging automatic switch. These added to the regular output of work will make this year's work even greater than the preceeding one.

POOLE & WHITE, LIMITED.

The business of this concern has grown rapidly during the past 12 months; it was found necessary shortly after commencing work, to open a manufacturing department, and it is expected larger premises will soon be opened. Attention has been devoted to the designing of special apparatus, such as switches, cut-outs, holders, ceiling roses, &c, and it is gratifying to find that the designs and specialities have been most favourably received by the trade. A large number of specially constructed switchboards have been made, some of them of considerable size. The Company thinks that the prospects are bright, and it is proposed to adhere to the present policy of confining business to wholesale supply, and has no intention of attempting contract or installation work of any sort. In this manner it hopes to keep up the present friendly relations with those who have so largely contributed to its success.

RANSOMES, SIMS, & JEFFERIES, LIMITED.

During the year 1890 Messrs. Ransomes, Sims, & Jefferies, Limited, of Ipswich, who have always been well to the fore in the adaptation of their engines for electric light purposes, have, we are glad to find, considerably extended their connections in this department.

They have supplied and erected a very fine 30 H.P. compound stationary engine at Fareham, in Hampshire, one of the small towns in which the electric light has been adopted.

At the recent Edinburgh Exhibition one of Messrs. Ransomes' 10 H.P. long-stroke engines was employed for driving the exhibits of Messrs. Norman and Son, Limited, giving, we understand, the most unqualified satisfaction.

In addition to these and other engines for England, Messrs. Ransomes have sent some of their engines this year for electric light installations in India, so that there is hardly any part of the world in which Messrs. Ransomes' engines are not found driving electric light machinery of various systems.

MESSRS. SHARP & KENT.

The following work has been carried out by this firm:—Houses of Parliament—160 H.P. boilers, engines, dynamos, pumps, and feed water heaters, and 8 underground mains of 61/10, each containing a ton of copper. Having received the order three weeks before the meeting of Parliament last February, the whole was supplied, put down, erected and started, and ran through the entire session.

They have supplied and erected for the Westminster Electric Supply Corporation at their St. John's Wharf Station, Westminster, boilers of 600 H.P., and engines and dynamos of 640 H.P.; for the Windsor Hotel, Westminster, 160 H.P. engines and dynamos; at Mr. Beale's, Holloway, 80 H.P. to increase his plant put down last year.

Also they have in hand engines and dynamos of 600 H.P. for the Corporation of Brighton, pumps, tanks, and all steam exhaust and water piping, &c.; also all the electrical apparatus in connection with measuring and testing instruments, switch boards, resistances, &c.

In addition this firm has wired for upwards of 15,000 lights.

TELEGRAPH MANUFACTURING COMPANY, LIMITED.

The works have been extremely busy during the past twelve months, and all departments have been fully employed.

The gutta-percha wire made by this company has been in such demand, that although the plant has been doubled, the supply has scarcely been able to keep pace with orders.

It has been found necessary to erect new buildings for the battery and insulator departments in order to cope with the work, and also to take large premises in Liverpool for the instrument department.

All these will be in working order in a few weeks, and then the whole extensive Helsby Works will be solely devoted to the manufacture of electric light, telephone and telegraph, wires and cables, and very shortly the company will be in a position to more than double their already large output.

WOODHOUSE AND RAWSON UNITED, LIMITED.

The year ending 31st December, 1890, shows very rapid strides and developments in the well-known undertaking of Messrs. Woodhouse and Rawson United, Limited, one of the most enterprising and progressive of the electrical firms.

The company in the beginning of the year removed their head offices from 11, Queen Victoria Street, to very extensive premises, having frontages, to 30, Cannon Street and 88, Queen Victoria Street respectively, but notwithstanding the size of the new premises, to meet the requirements of their increasing business, the company have been obliged to take the whole of an adjoining block of buildings forming the apex of a triangle facing the Mansion House Station, leading to Cannon Street on the right hand and Queen Victoria Street on the left. The new show rooms will be at 34, Cannon Street, and the secretary's office at 88, Queen Victoria Street.

Among the leading developments of the business may be mentioned the purchase and working of the large engineering works at Kidsgrove, near Stoke-on-Trent, lately carried on by Messrs. Renshaw, King & Co., at which place the company are able to cope with any demands which may be made for heavy mechanical engineering work, such as boilers, engines, central station dynamos, cranes, tanks, girders, hydraulic presses, &c.

Then, again, the important and growing business of electrical and steam launch building has been added to the other resources of the company by the purchase of the business of Mr. W. S. Sargeant, of Chiswick.

Important branch offices have been opened in distant parts of the world, viz., Sydney, Melbourne and Johannesburg, while other depôts such as Alexandria, Amsterdam, Barcelona, Bath, Bombay, Buenos Ayres, Cadiz, Cork, Dunedin, Hamburg, and Yokohama have been opened.

At their Cadby Hall Works the company have erected a huge new building to accommodate their largely increasing business in the manufacture of lamps, switches, fuses, switchboards, instruments of all kinds, &c. To provide the necessary power they are adding a large pair of compound engines, and the necessary boilers, and the whole of the shafting and tools will be run by electric motors.

We hear they have also added a new department for making an accumulator, of which great expectations have been formed; in addition they have largely increased their electro-plating facilities, so as to extend their out-door work for the trade, under the direction of Mr. William Elmore.

The Company has also during the past year introduced the following important enterprises, *i.e.*, the International Okonite Co., whose business has very largely increased since its formation, more than bearing out the statements in the prospectus, and whose specialities have been of very great assistance to those engaged in furthering the interests of electrical work, more especally in America, where the new works of the Company have more orders than they can supply. The Company has also aided in the successful sale of the French, German, and Austrian Elmore patents, and the commencement of working under the same.

In the important branch of the Company's business, known as the contract department, in which installation work is carried out, very marked and satisfactory progress has been made, and it is doubtless due to the fact that the principle has been most rigidly adhered to of not accepting or carrying out any cheap or inferior work. The very best materials that can possibly be bought, together with highly paid skilled labour, are only used, and the Company has the satisfaction of finding that a large proportion of the work secured by them comes through the recommendation of clients for whom they have already worked. In the Yorkshire districts alone 42 installations have been carried out by the Bradford branch. Among the more important may be mentioned, London and Yorkshire Bank, York Municipal Buildings, the Bradford Club, the Bradford Banking Company, the Borough Buildings, Bradford, Borough Court, Public Art Gallery and Free Library.

In the Lancaster district, among the larger installations carried out by the Manchester branch may be mentioned a 700 light plant for Messrs. Dobson & Barlow, engineers of Bolton, a second order having been received recently. The central station lighting work at Barcelona has been planned out by the company's engineers, and in a short time the new system of incandescent lighting plant with underground mains supplied by the company, will be in operation.

Repeat orders for installation work have been received from the Marquis of Ripon, Proprietors of Savoy Mansions, Crosse & Blackwell, Clowes & Sons, W. H. Smith & Sons, Strand, the Salisbury Club, J. W. Benson & Co., and other well-known firms, while among the more important maintenance contracts may be mentioned those of Drapers Hall, Exeter Asylum and Lord Brassey, whilst a part of the lighting work at the Edinburgh Exhibition has been carried out, and there is a very large quantity of work now in hand.

Supply Department.—Various articles of importance have been introduced to further electrical engineering, and the turnover has increased 100 per cent. in the last 12 months, whilst the new show rooms at 84, Queen Victoria Street, enables a still larger stock to be kept in the warehouse.

In the business of manufacturing the company holds the contracts for the London and North-Western Railway, Midland Railway, Great Eastern Railway Company, and the Caledonian Railway, and have executed contracts for the Admiralty, the General Post-Office, whilst many articles have been manufactured, such as galvanometers, signal repeaters, contact boxes, signal expansion tubes, firing keys, numerous electric bells of all sizes, relays, telephones, electric lighting switchboards, train starting and saloon indicators, single needle block instruments, lighting protectors, fusible and automatic cut-outs, lamps and automatic tachometers, many thousands of switches of all sizes, from 5 amperes upward, oil filters, large contracts for brass castings, automatic boxes, automatic advertising, coin checking and other automatic machinery, lathes, drills, screwmaking machinery, and other tools specially adapted for electrical work.

Amongst other heavy electrical engineering work carried out at Kidsgrove may be mentioned complete electrical and mechanical plant for a small central station at Palace Chambers, Westminster, complete mechanical and electrical plant for Woking central station, contract for supplying and laying 15 miles of mains for the Audley Local Board Waterworks, together with compound engines, boilers, 100 feet deep well and pumps, gaswork plant for Birkenhead Gas Committee, petroleum storage tanks, about 70 feet in diameter, capable of holding 2,000 to 2,500 tons of oil, for the Mersey Dock and Harbour Board of Liverpool; seven locomotive steam cranes of from 5 to 25 tons capacity, together with many high class engines and boilers, including steel boilers, 32 feet in length, water softeners, &c.

A considerable number of electrical launches have been built at the company's yards at Chiswick, amongst them being the *Volt*, the fastest ever built of her size, and various launches from 28 to 31 feet long, having an average of about 8½ miles per hour. For the English Government a very important departure has been made in building an electric pinnance capable of carrying 40 soldiers, another pinnance of this class having been already built for a steam yacht, four steam launches from 30 to 52 feet in length have been also built, the largest one for the Mexican Government. As steel launch building requires special appliances, a special yard has been recently laid out for building steel launches of every description. The company, after writing £7,000 off patents account, paid a dividend for the year of 15 per cent., put £25,000 to reserve fund, and carried forward over £16,000

REVIEWS.

The Romance of Science Series. Spinning Tops. The Operatives' Lecture of the British Association Meeting, Leeds, September 6th, 1890. By Prof. JOHN PERRY, F.R.S. London: Society for Promoting Christian Knowledge; Northumberland Avenue.

Perhaps but few could have any notion of how much interesting matter is to be obtained from the simple subject of "Spinning Tops." Prof. Perry has certainly produced a most entertaining and instructive volume which will be acceptable to all classes of readers, both young and old. The S.P.C.K. is doing excellent work in bringing out such works, which show that science has for the masses as great interest and more edification than the popular romances of the day.

The Romance of Science Series. Soap Bubbles and the Forces which Mould Them. A Course of Three Lectures delivered at the London Institution in 1889-90, *before a Juvenile Audience.* By Prof. C. V. BOYS, F.R.S. London: Society for Promoting Christian Knowledge; Northumberland Avenue.

In this volume, also, we have most interesting matter, a subject about which but comparatively little could apparently be said, developed in a very satisfactory manner. The statements of pure unmixed truth, which science asserts, and which are contained in these and other volumes of a like nature published by the S.P.C.K., must naturally help towards stemming the waves of religious scepticism which occasionally break stormily, and threaten to engulf the ignorant.

Handbook for Mechanical Engineers. By HENRY ADAMS, Professor of Engineering at the City of London College. 2nd edition. Revised and enlarged. London: E. & F. N. Spon, 125, Strand.

This volume originally appeared under the title of "Notes on Mechanical Engineering." The author has now recast these under the new title, and has included additional matter, so as to make the book more comprehensive. The whole work is written in a series of sections, divided into paragraphs, each with a heading of the subject it deals with. Practically, the information is such as is found in engineering pocket-books, with the addition of letterpress matter. A few brief notes on electrical subjects are included, and are of value. Altogether, the book is calculated to give considerable satisfaction, and is a decidedly useful addition to the long series of engineering works which have been published.

THE ELECTRIC LIGHT AT DOVER.

The following is a copy, courteously sent to us by the Dover *Standard*, of an article which is to appear this week in its columns :—

"The question of the introduction of the electric light at Dover came on for discussion again at the Dover Corporation on Tuesday, when the Mayor moved a resolution that the Town Clerk should apply for further information from corporations which have obtained provisional orders. The Town Clerk is to obtain information as to where corporations have undertaken the lighting themselves, and what systems they have adopted; and, in the second place, particulars as to any leases of concessions to companies, and what terms have been made. An allusion was made by councillor Peake to the severe criticism passed in the ELECTRICAL REVIEW upon Mr. Timmis, who had advised the corporation; and other members were of opinion that it was highly necessary before proceeding further with the matter that additional particulars should be obtained. Councillor Brown pointed out that if they leased their rights to a private company they would be at their mercy in having their streets pulled to pieces in the same way as they were now with regard to the gas lighting company, but it must be borne in mind that whether the Corporation undertake the work or not, the streets must be interfered with occasionally, and we should say that if a contract were made it could, with the aid of the Town Clerk, be so drafted so as to obtain a minimum of inconvenience. At any rate, if a great risk in public expenditure is to be incurred by the adoption of the light, by far the least of the two evils would be the granting of the concession to a company rather than the Corporation doing it themselves. Councillor Pepper pointed out that if the Council abandoned their rights they would open the way for a company to come in; but it is very clear that it is necessary for the Council to be in possession of further details in regard to the matter, which can without very much trouble be obtained, and which would be of the greatest value in guiding them to a decision.

NOTES.

The Electric Light at Portsmouth.—Surprise has been expressed that a committee appointed by the Town Council to take action for the purpose of introducing the electric light into Portsmouth has not yet made a report. It is understood, however, that considerable progress has been made with the preliminaries and that before long a comprehensive report will be submitted to the municipal body. The desire which exists for the new illuminant has been increased by the inferior quality of the gas supplied of late, the Corporation inspector having on several occasions reported it as below the standard. On a committee visiting the gas works, a quantity of coal in a state of combustion was brought under their notice, and the manager stated that this had been the case with many thousands of tons already used, and that in consequence of the combustion a large portion of the gas-making properties was lost. The committee have expressed the opinion that this partly-consumed coal ought not to have been used to produce the supply of gas for the borough, especially as the company appeared to have a sufficient supply of suitable coal available on the premises. A strong opinion exists among the shareholders of the Southsea Clarence Esplanade Pier that the large pavilion should be illuminated by the electric light and that this change would enhance the attractiveness of this favourite marine resort. The Esplanade Hotel and Assembly Rooms, in the immediate vicinity, already possess an installation.

Electric Lighting of Derby.—At the next meeting of the Derby Town Council the Electric Lighting Committee will propose that Sir Frederick Bramwell be instructed to report upon the best plan of Lighting by electricity the compulsory area under the Electric Lighting order.

Lighting Railway Lines.—An important step, which is worth emulating in this country, has just been taken by the Pennsylvania Railroad Company. The Company has entered into a contract with an electric light company, whose station is on the banks of the Delaware River, near Tacony, to light up a portion of its track, seven miles in length, through Frankford and neighbouring towns. This is on the main line to New York, and accidents are at present numerous owing to grade crossings and the large number of passing trains. It is hoped to minimise the numerous accidents by lighting the seven miles of track with a large number of arc lamps, which will render the track at night time as light as day, and over fifty miles of conductors will be used. If this experiment lessens the danger of accidents, the company will similarly equip other dangerous portions of the line. There is no doubt that this policy would be found of great advantage in this country. Even if only one mile of track were lighted outside of some of the London termini, it would greatly facilitate the bringing in of trains and avoid the present loss of time and money on the part of both the railway companies and passengers.

Electric Light and the Fogs.—We learn that both the St. James' and Pall Mall Electric Light Company and the Kensington and Knightsbridge Company, found no difficulty in contending with the foggy weather to which we have been recently subjected.

Electric Lighting of Cambridge. — Cambridge will apply to the Local Government Board for permission to borrow £35,000 for the purposes of the Cambridge Electric Lighting Order, 1890.

The Electric Light at Durham Cathedral.—A proposal has been made to light Durham Cathedral with electricity in future, instead of with gas, the power to be derived from the river Wear.

Electric Lighting of Hove.—The Electric Lighting Committee after considering the best means of carrying out the Order for supplying the electric light has recommended that the Commissioners should negotiate with a responsible company for the transfer to them of the undertaking, the chief reason for their decision being that in their strong opinion the initiation of the works would be most economically accomplished by a private company directly interested in the financial success of the undertaking. They recommend that Mr. R. E. Crompton, C.E., be appointed electrical engineer.

The City and South London Railway.—In commenting upon this railway, to which we also refer in another place, the *Daily Chronicle* says :—A difficulty has arisen in connection with the City and South London Electric Railway which, however temporarily gratifying to the company, was not contemplated when the Act of Parliament was passed, and may lead to serious action on the part of the local authorities. So many people desire to be passengers, that for hours every day there is a crowd waiting outside the station at Arthur Street. Small batches are taken in from time to time, but the accommodation is so utterly inadequate that one of the busiest roadways in the City is seriously impeded, and legitimate pedestrians are able to get by only with great difficulty. It is evident that the trains must be lengthened—which will involve a vast increase in electrical power—or the company must be compelled to acquire property adjoining their stations where intending passengers may wait. This is a provision which it will be necessary to have inserted in the Bill of the City and West End Railway, which is about to be brought before Parliament.

A Good Output.—Next week we hope to give some very interesting particulars of the daily work of one of our largest central stations. A number of curves are now before us, giving the output during each day of 24 hours, and the effect of fogs upon the formation of the curves is very clearly shown. The amount of electrical energy supplied on January 2nd was over 6,000 units, and on December 22nd it came to nearly the same figure, which, at 7d. per unit, makes a very respectable total. The company has nearly 14,000 lamps on its circuits.

Atlantic Cable Rumours.—We wonder whether there is even a modicum of truth in the published statements that a meeting has been held in London to arrange for the construction and laying of a new Atlantic cable, and that the necessary capital, £800,000, has been subscribed by 8 persons ? The proposition, said to be made, for a reduction of the tariff from one shilling to threepence per word may be dismissed as being too absurd, the proposer being probably unacquainted with either the limit of speaking through cables, or the financial part of the business.

The Okonite Business.—The notice issued by the directors of the International Okonite Company will be hailed with satisfaction by the shareholders. A dividend of 10 per cent. on ordinary and 8 per cent. per annum on preference shares, declared out of profits made since last summer is a matter for congratulation, and we wish the company continued success.

Official Returns.—The official returns of the Vaughan-Sherrin Electrical Engineering Company, which we publish on another page, will be found to contain some curious information. That the agreement of the 24th of October was not filed till after the 23rd of October, seems obvious on the face of it.

"Discovery."—A monthly journal "devoted to invention, scientific discovery, and the application of science to industrial purposes," has been brought out under this name. It is printed on good paper, and has a substantial appearance. We wish it every success.

Standard Electric Light and Power Company.—A general meeting of the contributories of the above-named company will be held on the 12th of February at 13, Victoria Street, to receive the liquidators final account and close the liquidation.

The French West-Indian Cables.—The Bureau International of Berne announces that the new cable between Mole St. Nicolas and Port au Prince (Hayti), belonging to the Société Française des Télégraphes Sousmarins, will be shortly opened to International service. The tariff will be an addition of 1·25 francs per word to the existing rates to Mole St. Nicolas. To other places in the Haytian Republic there will be an extra charge of 1·25 francs per telegram for postage.

Telegraph Rates to the River Plate.—It is announced that the tariff per word to the Republic of Uruquay *viâ* the Atlantic cables, Galveston, and the Central and South American Company's cables, has been fixed, commencing on Januaay 1st, 1891, at 7s. 3½d. This route embraces about 8,800 knots of submarine cable, and about 2,300 miles of land line.

Preparing Arms for Telegraph Posts.—A machine has been lately devised by Messrs. Pickles and Son, of Hebden Bridge, near Manchester, for the simultaneous shaping and boring of arms for telegraph posts. These arms, usually selected from the best English oak, vary from 2 feet to 4 feet in length. They are first planed on the four sides, and cut to the requisite lengths by machines specially made for the purpose, and are then passed along to the shaping and boring machine. At the official test of the machine, the wooden arms were finished at the rate of three a minute.

A Chance for Elmores.—The *Shipping World* says that the main steam pipes of ships' boilers are a frequent cause of disaster. It has long been known that in small boilers lap joints develop grooving along the line of the inner landing, and this, if undetected, leads sooner or later to an explosion. The same influence is at work in a lapped copper pipe. The *Shipping World* suggests, as a remedy, occasional annealing, and frequent tests by hydraulic pressure. Might we not suggest, in addition to these, that a more durable copper or copper alloy should be used.

The Telephone in Western England and South Wales.—A circular issued by the Western Counties and South Wales Telephone Company shows, in a striking manner, the rapid growth during the past few years of telephonic intercommunication between the towns of Western England and South Wales. During the last four months of 1887 there were 27,000 calls, and the receipts were £262 ; during 1888 there were 142,000 calls, and the receipts were £1,349 ; during 1889 there were 184,000 calls, and the receipts were £1,853, and during 1890 there were 248,000 calls, and the receipts were £2,774. Up to date every call has received a reply. Since December, 1887, the wire mileage has increased from 922 to 2,215.

New Electrical Companies in Vienna.—Three new electrical companies, with their headquarters in Vienna, have been successfully floated by the Anglo-Austrian Bank of that city, and Messrs. Siemens and Halske, of Berlin. The first is the Austrian General Electricity Company, formed for the purpose of constructing and working central electric light stations. The second is the Electric Tramway Company, formed to construct and work electric tramways. This company has already acquired the Budapest Electric Tramway. The third is called the International Compressed Air and Electricity Company, and is formed to work a concession obtained from the Vienna Municipality for lighting that city by electricity. The capital in each case is £312,000

Bath Electric Light Works.—Mr. M. C. Olsson, who was associated with Mr. Massingham for three years in his electrical engineering works at Taunton, and for the past two years has been chief electrical engineer at some large works on the Continent, has been appointed electrician in charge at the Bath Electric Lighting Works from the 1st. inst.

The Royal Society.—Among the papers down for reading last night was one by A. B. Basset, F.R.S., "On the Reflection and Refraction of Light at the Surface of a Magnetised Medium."

Electrically-Welded Coins.—A novel idea comes from America. The silver dollar there is found too large and the gold one too small to be convenient, and it is proposed that a silver coin worth 25 cents should be made with a hole in the middle, into which hole a golden plug worth 75 cents should be pressed. The New York *Electrical Review*, commenting on the proposal, suggests that the two metals should be electrically welded, and that the obverse of the new coin should be adorned with an ideal representation of the Goddess of Electricity in place of Columbia, who figures on the dollars of to-day.

The Popp System Again.—The Popp system in Paris does not appear to have a happy time. The Popp Company has now started accumulator stations in Paris, from which current is distributed. There has already been a fire in a distributing station under a café, necessitating the services of the fire brigade; and now an explosion has taken place in the accumulator station in la Rue de la Verrerie, four *employés* being injured. No details are at present forthcoming as to the real cause of the explosion.

L'Elettricita.—With the commencement of this year, our Milan contemporary *L'Elettricità* has become the official organ for the publications of the proceedings of the Italian Electrical Society, in the same way as the *Elektrotechnische Zeitschrift* is the official journal of the Electrotechnical Society in Berlin. In addition to this, it is proposed to improve the literary contents of the Italian journal.

Telephony in Spain.—A committee composed of French capitalists has laid before the Minister for Home Affairs in Madrid a scheme for the construction of telephone lines, to put into communication with each other all the chief provincial towns in Spain. According to the project, the work of putting up the lines and establishing communication would be completed 20 months from the commencement of the work.

Opinions Differ.—Sir Robert Rawlinson has written a letter to the *Contract Journal* on "The Snow Question and Utilising Water Power." To the first we need not refer, but our readers will be interested in seeing how the chief engineering inspector of the Local Government Board delivers himself on the subject of electric lighting. "There are very few places in Great Britain where water power can be made available for any of the purposes you name with true economy. Public lighting by electricity is a fad of the present day. When the money laid out upon it has been lost it will take its place with patent manure making out of road sewerage. So long as Great Britain produces coal, steam and gas will not be superseded. P.S.—We are going through various trials with electricity. For domestic lighting it will be confined to the rich. The proportion of its chances against gas will be as the rich are in numbers and wealth, to tradesmen and the poor, so will electric lighting be to gas. For some workshops, as, for instance, newspaper printing, electricity may be preferred to gas, but for out-of-door work, such as towns, shops, streets, and even railway stations, gas will hold its own."

Messrs. Rashleigh, Phipps and Dawson.—The first annual dinner and concert of the *employés* of the above firm took place at the "City Arms Tavern," in Blomfield Street, London Wall. The firm notify us that besides smaller establishments, they have recently accepted orders for the lighting of the Manchester Palace of Varieties, the St. James's Theatre, and Messrs. Lewis & Co., in Oxford Street.

Pacific Cable.—The *Canadian Gazette* of the 2nd inst., referring to the Pacific cable, says:—It is evident that the Australasian colonies are being brought one by one to realise the folly of complying with Sir John Pender's scheme for the continuance of the present Anglo-Australian cable monopoly. New Zealand and Queensland have declared themselves adverse to the proposed joint guarantee to the Eastern Telegraph Company to secure a reduction of rates, and we now learn from Victoria that the Postmaster-General of that colony has requested the Melbourne Chamber of Commerce to inform him whether, in its opinion the proposed method of cheapening cable rates over the existing system would militate against the construction of the proposed new cable by way of Canada and the Pacific. If it would, it might, he added, be a question whether it would not be better to abandon any reduction now, in preference to losing the chance of constructing the Pacific cable. This is exactly the view that must, the *Canadian Gazette* believes, prevail upon a full consideration of the facts. By subsidising the present cable system the Australasian Governments would be simply strengthening a monopoly against which they have struggled in vain for several years. If, on the other hand, they co-operate with Canada in the establishment of a new cable route, they not only destroy the monopoly, and free themselves from all the dangers of isolation which a single system involves in time of war, but they effect, by means of legitimate competition, a permanent reduction of rates, probably greater that which Sir John Pender's proposal would secure. In face of such facts as these, there can surely be no further hesitation in Australasia.

The Telephone in Berlin.—The Berlin telephone service has taken an almost incredible extension. The fifteen thousandth private apparatus has just been installed, and the establishment of an underground network is about to be proceeded with. The expenses of this important work are estimated at 2,000,000 marks, and 42,000 metres of piping will be laid to contain the conducting wires.

The Anglo-French Postal Convention.—This convention, which came to an end on January 1st, has been prolonged till March 31st next.

Gazette Notice.—The Portsmouth and South Hants Electricity Supply Company has resolved to voluntarily wind up.

Institution of Civil Engineers.—We hear that the numbers of the various classes now on the books of the Institution comprise 1,700 members, 2,880 associate members, 427 associates, 19 honorary members, and 927 students—together, 5,953.

New Year's Gifts.—The New Year has brought the usual list of diaries, almanacs, &c., whereby enterprising firms keep themselves before the public eye. Among others, we have received from Messrs. W. H. Willcock & Co. a handsome and useful date remembrancer, from Messrs. Shand, Mason & Co., the well-known makers of steam and manual fire engines another, ornamented with a realistic picture of a fire engine hurrying to extinguish a fire; from Messrs. Crompton & Co. a useful combined blotting pad and diary; Messrs. Appleton, Burbey & Williamson have sent us a neat porcelain memoranda tablet, for all of which we return thanks.

New Cables.—In view of the reduced cable rates to Australia, the Eastern Telegraph Company has recently laid a new cable from Suez to Aden. A second new cable will be completed in a few weeks for the section between Aden and Bombay. An additional cable, to be laid between Madras and Penang, is already completed.

Not Caused by Crossing Wires.—A large portion of the extensive brewery of Messrs. Arnold Perrett & Co., at Wickwar, Gloucestershire, was destroyed by fire on Tuesday morning. There were no fire appliances near, and it was two hours before the engines arrived from other villages. The main block, which is 64 feet square, was gutted, except a small portion protected by a concrete partition. The wings containing the offices and electric lighting plant were saved.

Davis and Timmins, Limited.—In our notice of "Progress of the Electrical Industries," on page 28 of last week's issue of this journal, through a misprint the address of Messrs. Davis and Timmins, Limited, new additional premises was given as 4A instead of 34A, York Road, King's Cross.

Incandescent Lamp Renewals.—We cannot expect an incandescent lamp to last for more than 1,000 hours; indeed after that period of running they are better thrown away, but the question of lamp renewal is really a very serious one. Let us take a house, say, fitted with 50 lamps of 16 candle-power, and supposing that on the average a lamp is in use for three hours a-day, we must renew them at the year's end at a cost of £15, that is, at the contractor's price of 6s. per lamp. The expenditure, indeed, for lamp renewals is, in some cases, said to be greater than that entailed for the supply of current, and it is certain that a considerable sum must be yearly set aside for this purpose.

The Institution of Electrical Engineers.—The first meeting will take place on Thursday, the 15th inst., when the President, Mr. W. Crookes, F.R.S., will deliver his Inaugural Address. On and after the 25th inst., the address of the Institution will be as follows: Victoria Mansions, 28, Victoria Street, Westminster, London, S.W.

Telegraph and Other Wires.—We have received a copy, under the Public Health Acts (Amendment) Act, 1890, of "Model Bye-laws with respect to Telegraph and other Wires." They are framed under Section 13 of the above Act, and may be made by any urban sanitary authority which has adopted Part II. (Telegraph, &c., Wires) of the Act. The pamphlet is published by Knight & Co., 90, Fleet Street.

A Year's Fires in London.—Many disastrous and fatal conflagrations occurred in London during the 12 months just ended. No fewer than 2,378 outbreaks had the Metropolitan Fire Brigade, under the guidance of Captain Shaw, to cope with, to say nothing of innumerable false alarms. Altogether the year 1890 has been memorable in the annals of London fires.

Fire at an Electrical Engineering Works.—On Tuesday last, at about 5 o'clock in the morning, a fire broke out at the West Drayton Works of the Electrical Engineering Corporation. It originated about the centre of the main fitting and machine shop. It was discovered immediately after the outbreak, and efforts were made to hold it in check with water from two hydrants on the premises, which had been erected to provide against such accidents. Despite all efforts, however, the fire spread so rapidly, that the water supply had to be utilised to prevent its seizing on adjoining buildings. The portion burned down includes a good deal of the new works erected during the last year, and containing some of the largest machine tools in use in the trade, several of which had never been put to work. The damage done is estimated at about £15,000.

New Business House.—The well-known firm of Richard Frères, of Paris, is about to open a branch office and showroom in London (at 43, London Wall, E.C.) for the extension of their business here in their specialities in self-recording scientific instruments. Mons. J. A. Berly, who is also well known to electrical engineers here, has undertaken the management.

Execution by Electricity.—The date fixed for the exodus of a Japanese murderer in New York is the 12th inst., but possibly an appeal may be made to the Supreme Court for stay of execution.

Personal.—Mr. W. A. Perry, late manager of Messrs. W. H. Vivian & Co., of Birmingham, has been appointed manager of the Phosphor Bronze Company's rolling and wire-drawing mills at Aston Road and Bagot Street, Birmingham.

Mr. William Mather, M.P., left Manchester on Saturday last for Russia. He is expected to return early in February to resume his parliamentary duties.

Electrical Bleaching.—The Manchester *Chemical Trade Journal* says:—"It does not augur well, however, for electrical processes to find that during the year one large plant on the Hermite system, installed at a cost of many thousand pounds, has been stopped and dismantled, the dynamos now being for sale, and the engines and building used for other purposes. Electrical methods have evidently received their quietus at this mill."

The Snowstorm in Pittsburg.—We learn that during the heavy snowstorm which visited Pittsburg last month, no less than 26 inches of snow fell within 24 hours. It is stated as being the heaviest storm ever experienced in that city. The damage to the telegraph, telephone, and electric light wires was enormous. The Western Union Telegraph and the District Telephone Companies estimate their damages at £10,000. The only serious accidents reported as being caused by the breaking of wires carrying heavy currents were the killing of two horses and knocking a street car driver off his seat.

NEW COMPANIES REGISTERED.

Ateliers Hoster de St. Nicolas, Limited.—Capital £2,000, in £20 shares. Objects: To take over the business of mechanical and electrical engineers carried on by Albert Hoster, of 51, Cannon Street, at St. Nicolas d'Aliermont, Department of Seine Inférieure, France; to manufacture and deal in apparatus and materials required for the generation, distribution, supply, accumulation, and employment of electricity. Signatories (with 1 share each): Albert Hoster and Mrs. Hoster, Grove House, Sydenham; F. Hoster, 38, Palatine Road, N.; R. Redie, St. Nicolas d'Aliermont, France; E. C. Wanguelin, 2, The Square, Hampstead; G. S. Ridley, 6, Great Winchester Street. Registered 30th ult., without special articles, by A. Hoster.

Albert Hoster, Limited.—Capital £2,000, in £20 shares. Objects: To acquire and develop the business of mechanical and electrical manufacturing engineer carried on by Albert Hoster at 51, Cannon Street. To manufacture and sell electric, telegraphic, surgical, and scientific instruments, and to carry on the business of electrical, mechanical, metallurgical, and chemical engineers and manufacturers. The signatories are the same as in the preceding company. Registered 30th ult. by A. Hoster.

Birmingham Telegraph Factory, Limited.—Capital £50,000, in £10 shares. Objects: To carry on business as telegraph and telephone engineers and contractors, and to manufacture all appliances and apparatus in connection with electric telegraph, telephone, cable, wire, or other similar work. Signatories (with 1 share each): *E. W. Lancaster (electrical engineer), Birmingham; J. Slater Lewis (telegraph engineer), Yardley, near Birmingham; *G. V. Fowler (electrical engineer), Longbridge, Warwick; Harold Mason, M.R.C.S., and Arthur Mason, Leamington; P. C. Bytheway, Wednesbury; Wm. Fowler, 69, Temple Row, Birmingham. The first three signatories are appointed directors; qualification, 50 shares; remuneration, £250 per annum, divisible. Registered 31st ult. by A. Mackenzie, Temple Chambers, Temple Avenue.

Hill's Plymouth Company, Limited.—Capital £250,000 in £10 shares. Objects: To acquire the Plymouth works and collieries at Merthyr Tydvil, county of Glamorgan. To generate, accumulate, distribute, and supply electricity for light, heat, motive power, or otherwise, and to manufacture and deal in apparatus and things required for the employment of electricity. Signatories (with 1 share each): N. F. Hankey, Chertsey; B. F. Hawkesley, Mincing Lane; J. Collins, 43, Bushey Hill Road, Camberwell; F. McNair, Tentern, Epsom; H. Palmer, 87, Harcourt Terrace, S.W.; Hy. Muller, 20, Rye Hill Park, Peckham Rye. Mr. F. A. Hankey, M.P., is appointed first director; qualification, £500 in shares or stock; the company in general meeting will determine remuneration. Registered 1st inst. by Hollams, Sons, Coward, and Hawksley, Mincing Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Barnet and District Electric Supply Company, Limited.—The annual return of this company, made up to the 1st inst., was filed 2nd inst. The nominal capital is £5,000, divided into 490 ordinary shares of £10 each, and 100 founders' shares of £1 each. 80 of the former, and the whole number of the latter are taken up, the founders' shares being credited as fully paid up. Upon 60 ordinary shares the full amount has been called and paid, and upon 20 shares £5 has been called and paid, the actual paid up capital thus being £700.

New Zealand Electrical Syndicate, Limited.—The registered office of this company is at the Battersea Foundry, Battersea.

Fowler-Waring Cables Company, Limited.—The annual return of this company, made up to the 19th ult., was filed 29th ult. The nominal capital is £200,000, divided into 39,700 ordinary and 300 founders' shares of £5 each; 20,000 of the former, and the whole of the latter (considered fully paid) are taken. Upon the ordinary shares the full amount has been called and paid, the paid up capital thus being £80,000.

Vaughan-Sherrin Electrical Engineering Company, Limited.—At a meeting of the board of this company, held at 116, Queen Victoria Street, on the 15th ult., it was resolved: "That the resolution of the board passed at a meeting held on the 23rd October, 1890, when the secretary was ordered to issue the following paid up shares to Mr. Thomas Richardson, 368; Mr. John Sherrin, 246; Mr. John Vaughan-Sherrin, 246; Mr. H. F. Woodgate, 54, be, and the same is hereby cancelled." That except as aforesaid all shares allotted, and all resolutions heretofore passed by the board or by persons purporting to act as directors, and all acts done under such resolutions be, and the same are hereby ratified and confirmed, and declared to be binding on the company. "That two directors shall form a quorum." The resolutions were duly filed on the 31st ult.

An extraordinary general meeting of the members of the company was held at 116, Queen Victoria Street, on the 16th ult., when it was resolved that: "The terms made with the vendors for the purchase of the Vaughan-Sherrin patents and the interest of Mr. Herbert Woodgate" in the patents having been explained to the meeting by the chairman that the terms of purchase be confirmed, and that the draft agreement produced at the meeting be approved, and that the directors be authorised to execute the same under the seal of the company, and to carry the same into effect. This resolution was filed on the 31st ult.

An agreement of 29th ult., filed 31st ult., between John Sherrin and J. Vaughan-Sherrin, cites that by an agreement of 11th August it was stipulated that £3,000 cash should be paid to the said John Vaughan-Sherrin, and also that there should be allotted to him nine founders' shares in the company, and a number of ordinary shares equal to the number then allotted to any other persons, so that he or his nominees should hold one half of the shares, such shares to be credited as fully paid up, in consideration of the purchase of patent rights. On the 23rd October the directors passed a resolution, in accordance with which the secretary was ordered to issue 914 fully paid shares, and the sum of £3,000 was paid by the company to the vendors. By an agreement of 24th October, the company agreed to be bound by the said agreement of 11th August, and by an indenture of 30th October, it was witnessed that in consideration of the said cash shares, the vendors assigned to the company the letters patent. Nothing has, in fact, been done under the resolutions of the 23rd October, and the agreement of 24th October was not filed until after the 23rd October, and doubts have accordingly been raised whether there has been an issue of the said 914 shares, and whether if there has been such issued, the same are fully-paid, having regard to section 25 of the Companies' Act, 1867. In lieu of the resolution of 23rd October, the following will apply. The purchase consideration to be £15,480, of which £3,000 has already been paid in cash, and £12,435 shall be satisfied by the allotment to the vendors, or their nominees, of 2,487 fully-paid up ordinary shares of £5 each, and £45 by the allotment of 9 fully-paid founders' shares.

The statutory return of the company, made up the 30th ult., was filed on the 2nd inst. The nominal capital is 4,975 ordinary and 25 founders' shares, of £5 each. Two founders' shares and 1,524 ordinary are taken up, upon each of which £3 has been called. The calls paid amount to £4,578.

Bernstein Electric Lamp Company, Limited.—The annual return of this company, made up to the 31st ult., was filed on the 2nd inst. The nominal capital is £100,000, in £10 shares. 2,814 shares are taken up, and the full amount has been called and paid thereon, the calls paid amounting to £28,140.

General Electric Power and Traction Company, Limited.—The statutory return of this company, made up to the 7th October, was filed 15th October. The nominal capital is £350,000 divided into 10,000 preference and 25,000 ordinary shares of £10 each, the whole of the former and 15,918 of the latter being taken up; 14,067 ordinary shares are credited as fully paid. Upon the remaining shares £4 per share has been called, the calls paid amounting to £16,339 10s. and unpaid to £31,064 10s.

CITY NOTES.

The International Okonite Company, Limited.

THE following notice has been issued:—

"The directors have decided to declare, payable on and after Thursday, 15th January, an interim dividend on the capital of the company. This dividend will be declared out of the profits of the company earned since the date of its registration, viz., 24th June, 1890. The profits, which were purchased by the company as from the 1st January until the date of registration (viz., £20,113), have been certified by Messrs. Price, Waterhouse & Co. to be in excess of the sum estimated in the prospectus as likely to accrue, but, according to the best advice which the directors could obtain, this sum is not available for the purpose of the payment of dividend, which must be paid out of the actual earnings of a company.

"The profits which have accrued since June enable the directors to declare, after payment of interest upon debentures, an interim dividend for the six months ending 31st December instant, on the paid up capital of the company, at the rate of 8 per cent. per annum upon the preference shares and 10 per cent. per annum upon the ordinary shares of the company.

"For the purpose of preparing dividend warrants, the transfer books will be closed from the 10th to 13th January inst. inclusive.

"The new factory at Newton Heath, Manchester, is rapidly progressing, and the costly machinery is nearly all ready for delivery. When this addition to the existing works comes to be fully developed, the directors confidently anticipate a satisfactory increase in the English business.

"P. J. BORDESSA, *Secretary.*"

The Direct United States Cable Company, Limited.—The Board has resolved upon the payment of an interim dividend of three shillings and sixpence per share free of income tax, being at the rate of 3½ per cent. per annum, for the quarter ending 31st December, 1890; such dividend to be payable on and after the 24th instant. The ordinary general meeting of the Company will be held at Winchester House on the 16th of January.

Elmore's French Patent Copper Depositing Company, Limited.—The share certificates are ready to be exchanged for allotment letters and all bankers' receipts. The offices of the Company are at 64, Cannon Street, London, E.C.

The Western Counties & South Wales Telephone Company, Limited.—The interest warrants on this Company's 5 per cent. debentures, for the half year ending Decemcer 31st, 1890, were posted on Tuesday last.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of December, were £3,000, as compared with £2,995 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of December, 1890, are £2,130 as against £2,187 in the corresponding period of last year.

The Great Northern Telegraph Company. Receipts in December, 1890, £23,600 1st January—31st December, 1890, £280,000; corresponding months 1889, £274,800; corresponding months 1888, £272,200.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 2nd, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £3,747.

The West Coast of America Telegraph Company, Limited. Traffic receipts for the month ending 31st December, 1890, £5,375.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Dec. 31).	Closing Quotation. (January 8).	Business done during week ending January 8, 1891. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	98 —101	97 —100 xd	99	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	48½— 49½	...	...
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84½— 85½	85 — 86	86	85
2,809,310*l*	Do. do. Deferred	Stock	13½— 13⅝	13½— 13⅝	13⅝	13 7/16
130,000	Brazilian Submarine Telegraph, Limited	10	11 — 11½xd	11 — 11½xd	11⅜	11¼
84,500*l*	Do. do. 5 p. c. Bonds	100	101 —103	102 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	102 —106 xd	102 —106	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½— 1⅝	2 — 2¼	2¼	1⅞
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1½— 2	1⅝— 2	1⅝	...
$7,216,000	Commercial Cable, Capital Stock	$100	102 —104 xd	102 —104 xd	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	½	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	...	...
16,000	Cuba Telegraph, Limited	10	11½— 12	11½— 12	...	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	16½— 17½	17½	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9½	...
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	10⅜	10 3/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13¾— 14¼	14 — 14¼	15⅛	14
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	14¾— 15¼	14¾	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	104 —107	104 —107	106½	105½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14 — 14¼	14⅛— 14⅜	14⅜	14⅛
320,000*l*	Do. 6 p. c. Debentures, repay February, 1891	100	101 —103	101 —103	...	...
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	102 —105 xd	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	102 —105 xd	103½	...
145,300*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	101 —104 xd	102⅜	101¾
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	101 —104 xd	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	100 —102	100 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7 — 7½	7 — 7½	7¾	7¼
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅜— 5¼	4⅜— 5¼	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3½— 4	4 — 4½	4⅜	4⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1½— 2	1⅝— 2¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8½— 9	8½— 9	9	8 1/16
180,042	Do. do. 6 p. c. Preference	10	14½— 14⅝	14⅝— 14⅞	14 13/16	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	16 — 16½	15⅞— 16¼xd	16 1/16	16
15,000*l*	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	101 —104	... ... xd	...	...
230,000*l*	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107	105	...
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,800	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	100 —102	100 —102	...	...
17,000	Indo-European Telegraph, Limited	25	35 — 37	35 — 37	37	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	9½— 10	9½— 10	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9½— 10	9½— 10	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£8 paid)	10	7½— 8	7⅞— 8¼	8	7⅞
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅛— 4⅜	4⅜— 4⅜	4 11/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12 — 12½	12 — 12½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	9⅜— 10¼	10— 10½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛— ⅜	⅛— ⅜	...	...
9,000	Reuter's Limited	8	8½— 9	8½— 9	8⅝	...
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ⅜	⅛— ⅜	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½— 3	2⅝— 3½	...	...
3,381	Submarine Cables Trust	Cert.	110 —114	110 —114	112⅜	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	5	4⅜
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	45	...
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102	100 —102 xd	...	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 95	90 — 95 xd	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ... xd	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9 xd	8 — 9 xd	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	...	...
130,000	West Coast of America Telegraph, Limited	10	2 — 4	2 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —102 xd	97 —102	...	...
64,174	Western and Brazilian Telegraph, Limited	15	10¾— 11¼	10⅝— 11¼	10 15/16	...
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6⅝	6¼— 6⅝	6 9/16	6 7/16
27,873	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4½— 5	4 11/16	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	2⅝— 3	2⅝— 3	3	2 15/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11¼— 11⅜	11¼— 11⅜	11⅜	11 7/16
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11 — 12	11 — 12	11½	10½
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	99 —103	99 —103	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	2½— 3	2½— 3	...	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2⅜—2⅝.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅝—1⅞.—Manchester Edison and Swan Company, £9 (£1 paid) 11s.—13s.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 1⅞—2⅛.—Preference, 4⅜—4⅝.

BANK RATE OF DISCOUNT.—4 per cent. (8th January, 1890).

INDUCTANCE AND ITS PROPOSED UNIT THE HENRY.*

BY A. E. KENNELLY.

PERHAPS the greatest discovery of Faraday's long career of scientific research was that of electro-magnetic induction in the year 1831, when he first brought to light the influence exerted by a magnet or a current upon surrounding matter when subjected to a change of magnetic potential. Oersted had shown that a conductor carrying a current exercised electro-magnetic influence at a distance, and Ampère had enuncisted those simple and beautiful laws this influence is admitted to obey, but Faraday's discovery was a great step; it revealed the action of magnetic force in apparently empty space; it inaugurated that deeper insight into the mechanism, still only dimly guessed, which connects matter with all other matter in space; and it invested the all pervading ether with a dignity and power that in the hands of many great men since his time, has probably paved the way for our future comprehension of magnetism, gravitation, and radiant energy, while making the hypothesis of action at a distance a mere mathematical conception and process of thought.

The development of this discovery of electro-magnetic induction has practically created electrical engineering, for it is to machinery operating by electro-magnetic induction that we owe nearly every branch of electrical industry except, perhaps, telegraphy, the forerunner of all; and the condition of modern electrical engineering is such that the units and nomenclature relating to steady currents and permanent magnets is insufficient for practical requirements, and the conditions developed by variable currents and magnets demand the establishment of engineering practical units for the purposes of convenience in expression and computation.

Foremost among these required units is that of inductance, or as it is commonly called the coefficient of induction. This inductance is a property fully as essential to every electric conducting circuit as resistance and electro-static capacity, and the inductance of a circuit when conveying variable currents is often a far more important factor in regulating the flow than the ohmic resistance. In fact we know that Ohm's law does not apply to a circuit so long as the current is unsteady, unless the inductance of the circuit or the counter electromotive force it involves be introduced into the expression.

In conformity with the conventional and so-called absolute units of electro-magnetism, an inductance is a length, and theoretically it can always be computed from the geometrical relations of a circuit; that is to say, if the distance of each point from all other points of a circuit be measured, or inferred, in inches or centimetres, the inductance of the circuit will be some definite number of inches or centimetres, capable of being determined by a possible if not a convenient process of summation. If the circuit, however, be associated with iron or other magnetisable matter, then the magnetic permeability of the environment will enter the terms of summation as a multiplier. In the absolute centimetre-gramme-second system of units, inductance will be necessarily expressed in centimetres, and the centimetre is thus the natural scientific unit, although unsuited to the requirements of electrical engineering.

It may be well to notice that inductance is only conventionally and perhaps not essentially a length. Prof. Rücker has pointed out† that the multiplication of the permeability factor with the length factor is always tacitly, if not expressly involved, even when the circuit considered is far from magnetisable matter in the ordinary sense; that is to say, when residing in a medium of unit permeability, and therefore the nature of inductance is not merely length, but length multiplied by permeability, while physics has not yet decided whether permeability is the simple numerical factor at present assumed, or a function of length, mass and time. Until this question is settled, the real nature of inductance must be considered as doubtful, and the fact that inductance will probably, in any event, be always measured by lengths is no more validly an argument as to its nature, than the usual determination of a body's mass by the earth's gravitational force upon it is an argument that mass is a force. However, the question is one of theory only, and does not affect the consideration of the practical unit.

As has been pointed out by Dr. Sumpner,‡ there are no less than three ways of defining the inductance of a circuit, or a portion of a circuit, and the three definitions are equivalent when the permeability of the magnetic medium is unity, but are not generally equivalent in the opposite event, being then only related in a definite manner by the magnetic properties of the medium. In other words, the inductance of a hollow solenoid of copper wire, placed in a vacuum, and far from all iron, has the same numerical value in each of the three definitions; but if an iron core be inserted in it, its inductance will depend upon the definition selected, and will only be capable of interpretation from its value in one to its values in the others, by taking into account the characteristic permeability curve of the iron, and the conditions of the measurement.

For convenience and general use, however, the secondary definition of Sumpner and Fleming§ is probably the best to adopt, and valuations in the other two can be reduced if necessary to this when the data for so doing are available.

The inductance of a circuit, or portion of a circuit, is then the ratio between the total induction through it to the current producing it. Thus taking a simple helix of five turns carrying a current of two units, and assuming that 1,000 lines of force* passed through the central turn, of which, owing to leakage, only 900 thread the next adjacent on each side, and again only 800 through the end turns, there would be 800 + 900 + 1,000 + 900 + 800 or 4,400 linkages of lines with the wire, and this being with 2 units of current, there would be 2,200 linkages with unit current, and consequently the self

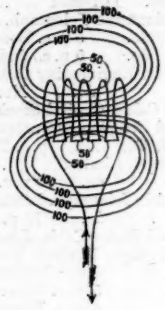

FIG. 1.

inductance of the helix would be 2,200 centimetres. (Fig. 1.)

The fact that such helices are used in galvanometers, and that the magnetic force at any point within them is admitted to be proportional to the strength of the traversing current, renders it evident that had the current in this case been one unit, 2,200 lines linked with the coil would actually have been produced. Supposing, however, that the helix had been wound upon an iron core, the total number of linkages with the same two units of current would have been greatly increased, perhaps twenty-fold, or to 88,000, and the inductance then by the same rule would be 44,000. In this case one unit of current would not, in all probability, reduce the number of linkages to 44,000, the exact number would depend upon the characteristic curve of the iron core, and the degree of saturation, so that it would now be necessary to state the conditions of the measurement along with the result, in order to convey a clear and definite meaning.

It appears anomalous at first sight to state the above inductances in centimetres, when they are derived from the number of lines of force; but it is to be remembered that the total number of linkages is divided in each case, not by a mere numeric, but by a current, and this quotient can be proved to be a length in the existing system of dimensions.

In the same way the mutual inductance of two conductors is the ratio of the total induction through one of them to the strength of current in the other producing it. Suppose two coils of copper wire to be held in free space far from iron, and let one of them be traversed by a steady current of, say, four units. Of all the lines of force issuing from this coil, suppose 500 pass through the other coil. For simplicity, imagine the second or recipient coil to be composed of eight turns, so disposed, that the 500 lines pass through all in succession. There will then be 4,000 linkages of lines with that coil, and the mutual inductance of the two will be 4,000 ÷ 4, or 1,000 centimetres. It is interesting to notice that the same result would be reached if the second coil had the current, and the linkages were counted in the first, the pair being mutually conjugate in this respect, provided they reside in a medium of constant permeability.

Thus far, we have only considered the centimetre or absolute unit, whose unfitness for practical use is evident, since the smallest inductance that is at present known to engineering amounts to several thousand, while the average values met with are counted in millions of centimetres. It would, of course, be possible to name suitable units from the metrical system of lengths, but it is the proposal of this Institute to adopt the word Henry as the practical unit, in honour of the man, who, beyond all doubt, was among the foremost to extend the knowledge thus far possessed of self and mutual inductance.

If the selection of the practical unit were entirely free and subservient only to practical requirements, so that its magnitude should express ordinary values in digits with fewest decimals on the one hand, or large numbers on the other, there seems most reason to believe that the thousandth of the earth-quadrant or myriametre would be the most eligible.

Proposed Name.	Length.	Number of centimetres.	Unit.
Henry	Earth quadrant.	1,000,000,000	Practical unit.
		100,000,000	
		10,000,000	
Millihenry	Myriametre.	1,000,000	
	Kilometre.	100,000	
	Hectometre.	10,000	
Microhenry	Decametre.	1,000	
	Metre.	100	
	Decimetre.	10	
	Centimetre.	1	Absolute unit.

* A paper read at the 52nd Meeting of the American Institute of Electrical Engineers, New York, December 169h, 1890. Subject to revision.

† "Phil. Mag.," February, 1889. 5th series, vol. 27, p. 104.

‡ Phil. Mag., June, 1888. 5th series, vol. 25, p. 453.

§ "The Alternate Current Transformer," by J. A. Fleming, vol. i., p. 55.

* The term line of force here is used in the sense of a line of induction; the distinction being necessary when the lines pass through iron.

Of course, large iron machines employing many turns of wire linked by dense magnetic fields, would have inductances more appropriately expressed in earth quadrants, which might then be termed the Kilohenry, just as we now have the watt and kilowatt, but there is one restriction which makes such a selection undesirable, and that is the hitherto unbroken system of practical units itself. This practical system is a sub scheme of the great international C.G.S. system, and especially planned for adaptability to practical requirements. It is derived from that parent system by the substitution for the unit of length one thousand million centimetres in place of one centimetre, and for the unit of mass an impalpable entity definite only in thought, the one-hundred millionth of a milligramme in place of the gramme. By this substitution in the C.G.S. electro-magnetic units, we obtain the hitherto unbroken system of the volt, ohm, ampère, coulomb, joule, watt, and farad. Even these units are not always the most convenient, witness, for example, the microfarad in common use, whose prefix is maintained simply in deference to the harmony of the system, for the farad is a capacity that exists only in imagination; the capacity of the earth itself being only about 700 microfarads, and of the sun, or rather a sphere having the apparent dimensions of the sun being only about 76,000 microfarads. On the other hand, a proposition has lately been made to infringe the system by making the volt, the ampère, and the watt ten times their present values, on the ground of practical convenience.* However, at the present time, it would surely be unadvisable to attempt the precedent of infringing a system that has hitherto been supported by time, custom, and International Congress.

In this practical system, the unit of inductance must be 1,000 million centimetres. That is an earth quadrant or the distance from the pole to the equator, measured on the meridian of Paris. Strictly speaking, it is only the quadrant of the French standard earth, which is about one-tenth of one per cent. shorter than the acknowledged actual earth quadrant, according to the best determinations, but the fact of the latter being 10,001 kilometres, instead of 10,000, is a matter of precision in definition only, and in no way affects the practical unit.

As regards the history of the subject, it would appear that prior to 1887, measurements and deductions were confined to scientific works, and were expressed in absolute units—centimetres. In that year, however, a paper was read before the British Institution of Electrical Engineers by Messrs. Ayrton and Perry,† who invented and developed a practical measuring instrument for the measurement of inductance, who, aided by Dr. Sumpner, made important contributions to the literature of the subject, and who proposed a name provisionally for the practical unit. That name was the secohm, a contraction of second-ohm, implying the fact that the product of the two was the length equal to the practical unit. They drew attention to the fact that since the Paris Congress of 1884 had fixed the standard legal ohm as the resistance of a column of mercury at zero Centigrade, 106 centimetres long and 1 square millimetre in cross section, whereas the true ohm was in all probability 106·3 centimetres, or one-quarter of 1 per cent. greater, the inductances measured in the manner they suggested from seconds and legal ohms, would be in terms not of the standard earth quadrant of 10,000 kilometres, but of legal earth quadrants 9,778 kilometres in length. The difference practically is not very great, but to avoid error or confusion in definition, they advocated provisionally the term secohm, in place of quadrant.

The Paris Congress of 1889 adopted the "quadrant" as the practical unit of inductance, defining it as 1,000 million centimetres.

The practical range of inductances is second only to that of resistances, and the latter we know from a few microhms up to thousands of megohms. The smallest inductances are those of Hertz resonators which descend to the order metres. Excluding these, however, the smallest are perhaps met with in measuring instruments intended to have negligibly small inductance, such as doubly-wound resistance coils, Cardew voltmeters, and the like. These descend to the order of decametres, and can generally be expressed as such without prefixing decimal points. It is evident that the term microhenry would suitably apply to their designation. At the other end of the scale we find large induction machines linking dense fields with many turns of wire, and reaching inductances of hundreds or even thousands of henrys. Intermediate between these limits, there exists a large class of circuits having many turns but little iron, or clad in iron with few turns of wire, and these seem to be best expressed by the term millihenry, equivalent to the myriametre.

With the object of setting forth the advantage to be derived from the use of this nomenclature, it may be permissible to adopt it provisionally in describing the measurements that follow. These measurements have been made on different types of apparatus at different times and by different methods, so that they represent mean values from several observations in many cases, but allowance must be made for the variations of standard and type.

In telegraphy, the inductance of an ordinary Western Union 140-ohm relay is about three henrys with the armature drawn well back, and nine henrys with the armature pressed against the poles. In the latter case, af course, the magnetic reluctance of the iron circuit is a minimum, and the same current in the coils causes three times as many lines to circulate through the iron. At the position of the armature in ordinary adjustment the inductance is about five henrys.

The inductance of an ordinary standard 10ω relay is from 200 to 500 millihenrys, according to the position of the armature relatively to the poles.

The inductance of an ordinary sounder is similarly from 25 to 50 millihenrys. These inductances are the values obtained with only a few milliampères through the coils, and since the path of the induction is largely through iron, the inductance varies with the strength of the current used. Practically, however, the variation is small within the range of current at which instruments usually operate.

Submarine Telegraphy.

The inductance of a mirror speaking galvanometer of the ordinary type having 2,250 ohms was found to be 3·6 henrys.

Telephony.

The inductances met with in the ordinary long distance telephone apparatus are as follows:—

The call bell 80 ohms and 1·4 henrys.

The magneto armature 550 ohms, and from 2·7 henrys with the plane of the coil in the line joining the poles, to 7·3 henrys when the iron core joins the poles, the plane of the coil being then at right angles to the magnetic flux.

The induction coil primary 0·28 ohm and 3·5 millihenrys.

Secondary 164 ohms, and 734 millihenrys.

The mutual inductance between the coils 60 millihenrys.

The Bell telephone receiver 75 ohms and from 75 to 100 millihenrys. The removal of the diaphragm from an ordinary telephone of this type reduces the inductance about 35 per cent. All these inductances are to currents of a few milliampères only. As regards the inductance of aerial line wires, it is to be regretted that measurements are not yet forthcoming, and indeed the experimental determination is attended with some difficulty, owing to static capacity and imperfect insulation. In the absence of direct measurements, theory indicates that the inductance of overhead copper wires depends upon the elevation above the ground as well as upon the diameter. In the case of iron wires, as used in telegraphy, the permeability of the iron enters as an additional factor. The following table of inductances for copper wires, is based upon a formula first given by Clerk Maxwell.* It is to be hoped that experimental evidence may shortly be collected corroborating these results:—

Table of Inductances of Copper Aerial Line Wire, per Kilometre and Mile, for Different Diameters, and Elevations Above the Ground.

Diameter of wire.		Elevation above ground 400 cms. or 13·1 feet		Elevation above ground 700 cms. or 23 feet.		Elevation above ground 1,000 cms. or 32·8 feet.		Elevation above ground 1,300 cms. or 42·7 feet.	
Centre-metre.	Inches.	Millyhenrys or myriametres.		Millihenrys or myriametres.		Millihenrys or myriametres.		Millihenrys or myriametres.	
		Per kilo-metre.	Per mile.	Per kilo-metre.	Per mile.	Per kilo-metre.	Per mile.	Per kilo-metre.	Per mile.
0·10	0·039	1·986	3·196	2·109	3·393	2·170	3·493	2·222	3·576
0·20	0·079	1·848	2·974	1·960	3·154	2·031	3·268	20·83	3·352
0·30	0·118	1·766	2·842	1·878	3·022	1·950	3·138	2·002	3·222
0·40	0·158	1·709	2·750	1·821	2·930	1·892	3·045	1·945	3·130
0·50	0·197	1·664	2·678	1·776	2·858	1·847	2·973	1·900	3·058
0·60	0·236	1·628	2·621	1·740	2·800	1·811	2·914	1·863	2·998
0·70	0·276	1·596	2·569	1·709	2·750	1·780	2·865	1·833	2·950
0·80	0·315	1·570	2·527	1·682	2·706	1·754	2·823	1·806	2·906
0·90	0·354	1·547	2·489	1·659	2·669	1·730	2·785	1·783	2·870
1·00	0·394	1·526	2·456	1·638	2·635	1·709	2·750	1·761	2·834

The inductance of iron wires, in the absence of measurements, is almost too doubtful to justify calculation, being perhaps 10 times more than the inductance of copper wires under similar conditions. The difficulty in their case lies in assigning the proper value of permeability.

Electric Light and Power.

Dynamos and dynamo-electric machinery are of course generally characterised by large inductances.

The inductances of the field magnets of a dynamo may have any value depending on the size and voltage of the machine from one henry up to 900 henrys.

The inductance of an armature may similarly vary from 20 millihenrys up to 50 henrys between brushes. One millihenry is a fair average value of the inductance of one section of an armature. Armature inductances depend not only on the strength of the measuring current, but also upon the strength of the field, and whatever influences the permeability of the core.

The inductance of an alternating transformer varies from a primary of 400 millihenrys, a secondary of one millihenry and mutually 20 millihenrys with a transformation ratio of 20, up to corresponding values perhaps 100 times as great.

Apparatus. The Inductance of Ruhmkorff Coils.

The smallest medical coil in ordinary use has five millihenrys in its primary, 100 millihenrys in its secondary, and 20 millihenrys mutually between them.

A large induction coil 19 inches long and 8 inches in diameter has 0·145 ohms and 13 millihenrys in its primary, 30,600 ohms and 2,000 henrys (by two concordant methods of measurement) in its secondary, and 163 henrys mutually between them.

* The *Electrician*, of London, September 19th, 1890, p. 558, Report of British Association Discussion.

† *Journal* of the Institute of Electrical Engineers, London, April, 1887, Vol. xvi., p. 291.

* Clerk Maxwell, "Electricity and Magnetism," 2nd Edition, vol. i., p. 293.

The inductance of a mirror galvanometer may vary from a few millihenrys up to 10 or more henrys according to its resistance. Two henrys is a fair average for an astatic mirror galvanometer of of 5,000 ohms.

An ordinary electric bell of 2·5 ohms resistance was found to have an inductance of 12 millihenrys.

There is one point in connection with the self and mutual inductance of induction coils and transformers, that deserves attention owing to the confusion that occasionally arises concerning it. It may be, perhaps, best represented by a numerical example. Let a closed Faraday ring of iron 100 centimetres in mean circumference and 20 square centimetres in uniform cross section, be closely wound with a primary coil of 2,500 turns in one layer, followed by a secondary coil of 7,500 turns also in one layer, If now 2 ampères be maintained steadily through the primary, the magnetic force in the iron will be $4\pi/10$ times the ampère turns per centimetre of the iron circuit or $4\pi/10 \times 2 \times 2{,}500 \div 100$ or 62·85. The permeability of wrought iron at this force being, say, 250, the induction developed per square centimetre will be $250 \times 62{\cdot}85$ or 15,713 lines, and the total induction enclosed by the primary coil, neglecting the space occupied by the wire itself will be $20 \times 15{,}713$ or 314,250 lines which traverse every turn of both windings. The linkages with the primary will be $2{,}500 \times 314{,}250$, or in round numbers 786,000,000 and referred to one ampère, half this number, or an inductance of 393 million centimetres, that is 393 millihenrys. Similarly the linkages of these lines with the secondary will be 2,358 millions, and per ampère of primary current, 1,179 millions of centimetres mutual inductance or 1·179 henrys. Next suppose the primary current interrupted, and a current steadily established in the secondary sufficient to produce the same magnetic force in the iron, thus avoiding the complication of a changing permeability, As the secondary has three times as many turns, the current effecting this will be two-thirds of one ampère. The total induction through the iron will now be the same as before, and therefore the linkages will be equally numerous. The self-inductance of of the secondary will be $2{,}358{,}000{,}000 \div \frac{2}{3}$, or 3,537,000,000 centimetres, that is, 3·537 honrys. The mutual inductance will similarly be $786{,}000{,}000 \div \frac{2}{3}$, or 1·179 henrys, as before. It will be found, on carrying the reckoning to the necessary degree of accuracy, that this mutual induction, 1·179, is the square root of the product of the two self-inductances, $0{\cdot}393 \times 3{,}537$.

Examination of the steps in this calculation will show that this proposition must hold for all closed magnetic circuits uniformly magnetised to the same degree when the space occupied by the windings is not taken into account. Under the opposite conditions of open and especially of short iron cores, with large winding spaces, the condition usually falls, and the mutual inductance may be greater or less than the square root of the self-inductances multiplied together.

Another reason in favour of selecting 1,000 million centimetres as the value of the practical unit or Henry, is the desirability of having the time-constant of an electro-magnetic circuit expressed directly in seconds by its practical units, as in the case of electrostatic circuits, rather than revert to a unit of inductance that would yield the time constant in milliseconds or other fractional period of time. The time constant of a simple electro-magnetic circuit, a circuit having inductance and resistance, but negligibly small electrostatic capacity, is defined as the ratio of its inductance to its resistance, that is, of its henrys to its ohms. It is an important function, and its consideration presents some remarkable analogies between inductance and electrostatic capacity that it is interesting to trace.

Imagine an inductance coil, C, without iron to be supplied with a steady current from an electromotive force, E, of 50 volts. Let the inductance of the coil be three henrys, and its resistance 10 ohms. (Fig. 2.) Ohm's law determines the strength of the current to be 5 ampères. Now short-circuit the terminals of the coil very suddenly by a wire across its terminals of negligible resistance. The current in the coil, C, does not stop instantly, but under the name of extra current is maintained in the coil by reason of its inductance. According to theory, the last dregs of the current will never entirely vanish from the coil, although after the first few seconds the remainder is exceedingly small. The very first instant after short-circuiting, the current continues at 5 ampères by its electro-magnetic momentum, but being unsupported, its energy is lost thermally in overcoming the coil's resistance, and it immediately falls. In falling, the lines of force linked with the circuit and sustained by the current are drawn in, cutting the coil as they recede, thus creating a counter E.M.F. tending to prolong the current, and this process of dwindling current with reduction of opposition from the reserve of inductance, descend together. The total quantity of electricity that will flow through the circuit under the conditions specified, may fairly be called the charge or discharge of the coil, and it can be readily proved that this charge is equal to the quantity that would be conveyed by the initial discharging current, acting uniformly during a time equal to the time-constant of the circuit. In this case the discharge commenced at 5 ampères, and the time-constant is 0·3 second, so that the total discharge will be that due to the flow of this current in 0·3 seconds, that is, 1·5 coulombs.

To represent the case graphically, suppose the curve of discharge in time to be plotted as in the figure. Let the axis, O, X, be divided off into seconds, and the axis, O, Y, into ampères. (Fig. 3.) The discharge commences at 5 ampères, subsides rapidly at first, but at last so slowly that an indefinitely long time must elapse before it altogether disappears. The area enclosed between the curve and the axes represents ampère-seconds or coloumbs to the amount of the total charge, and the proposition just stated asserts that if the current had continued at 5 amperes steadily for 0·3 seconds, the area of the dotted rectangle so generated, Y, D, T, O, would be equal to the total area enclosed between the curves and the axes prolonged to the ultimate point of union.

Curiously enough, exactly the same law applies to the discharge of a condenser through a circuit of resistance but negligibly small inductance. The time-constant of the circuit in this case, however, being its capacity in farads multiplied by its resistance in ohms.

The curve of discharge is of the same type for inductances or capacities. It is logarithmic, and finds its prototype in the case of the discharge of water in time, from a tank having a faucet at the base, assuming that the rate of escape through the faucet at any moment is directly proportional to the pressure, or level of water then remaining in the tank.

The laws which control the outline of this discharge curve are identical for condensers or short-circuited inductances, and are combined in the following enunciation:

The natural logarithm of the ratio of the $\left\{\begin{matrix}\text{full charge}\\\text{initial current}\end{matrix}\right\}$ to the $\left\{\begin{matrix}\text{residual charge}\\\text{discharging current}\end{matrix}\right\}$ at any instant is the quotient of the time during which discharge has been in progress by the time constant of the circuit

In this statement two reservations are necessary.

The electrostatic circuit must be free from all appreciable induct-

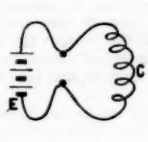

FIG. 2.

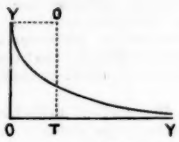

FIG. 3.

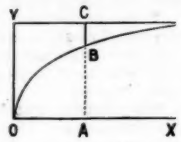

FIG.

ance, and the electro-magnetic circuit must contain negligibly small electrostatic capacity. It was first pointed out by Sir William Thomson that the discharge of a condenser through an inductance circuit, becomes oscillatory when the inductance exceeds a certain critical value.

When an inductance discharges through a break instead of a closed circuit, the conditions become complicated to a degree that eludes complete practical solution in the present state of knowledge.

At the period of natural discharge equal to the time constant, an inductance or capacity charge or current will have fallen to 36·8 per cent. of its initial value.

Similar propositions relate to the charging currents and quantities. In the above instance, after the coil has completely discharged, remove the short-circuiting wire. The current will immediately enter the coil, and the curve of its arrival in time is represented in fig. 4, this curve being only an inversion of the preceding. For this reason it is evident that the area above the curve now represents the charge, and by an extension of meaning, the deficit from full current, such as B, C, may be called the charging current, since on discharge and reversal of the diagram, this will be the discharging current at the same lapse of time. In fact, the current, A, C, is doing work in heating the coil, the deficit from ultimate current, B, C, being only active in increasing the electro-magnetic momentum of the circuit, and work is really stored in the coil as though the deficit current did exist. A similar but inverted curve of current in time represents the charge of a condenser. In each case, and under the above restrictions, the following propositions hold:

The natural logarithm of the ratio of the $\left\{\begin{matrix}\text{full charge}\\\text{initial current}\end{matrix}\right\}$ to the $\left\{\begin{matrix}\text{deficit from full charge}\\\text{charging current}\end{matrix}\right\}$ at any instant is the quotient of the time during which the charge has been in progress by the time constant of the circuit.

When the charging interval reaches the time constant, the charge will have attained 63·2 per cent. of its full value.

Another relation between simple electrostatic or electro-magnetic circuits and their time constants is in their stores of energy. The energy of the charge in each case is half the energy that would be developed by the initial charging or discharging current against the ohmic resistance of the circuit in the time equal to the time constant. In the above instance, for example, five ampères being the initial charging or discharging current, and the resistance 10 ohms, the circuit energy of this current per second would be $5 \times 5 \times 10 = 250$ joules, and during half the time constant, the energy thus developed would amount to $0{\cdot}3 \times 250 \div 2$, or 37·5 joules. This is the electro-magnet energy stored up in the charge.

These are not the only analogies that exist between inductance and capacity, but there are remarkable points of diversity. The discharge of extra current of a coil is in the same direction as the circuit current; with the condenser it is the reverse. In a great many practical instances, the electro-magnet and the condenser are used to annul each other's influence.

The time constant of an inductance circuit is generally small, for the reason that a coil of large inductance has generally many turns, and therefore high resistance, so that the ultimate ratio of the henrys to the ohms is not large. For example, the time constant of a Bell telephone, considered in itself or on short circuit, is from the measurement above described, about $0{\cdot}09 \div 75$ or 0·0012 seconds, and therefore a steady E.M.F. of, say, two volts, impressed directly upon such a telephone would produce in this interval of time 63·2 per cent. of 2/75 ampères, namely 169 milliampères. By adding inductanceless resistance to the circuit, however, and raising the E.M.F. proportionately, the time-constant would be lessened, and the arrival of current accelerated. Strictly speaking this reasoning is inaccurate, since the telephone coil surrounds iron, but with the small currents usually employed, the iron probably does not greatly influence the arrival curve. In the case of dynamo field-magnets, and large ironclad inductances generally, the divergence of the arrival

curve from that of a corresponding simple electro-magnetic circuit is considerable.

There are several methods by which self and mutual inductance can be measured, the selection depending on the magnitude to be determined and its nature. The Ayrton and Perry sechommeter or double revolving commutator is perhaps the most generally useful. It may be employed in connection with a standard condenser, a standard inductance, or apparent change of resistance with speed. Being used in the Wheatstone Bridge, the currents it can alternate are necessarily limited in strength.

For small inductances,* say less than one-tenth of a millihenry, the method of Prof. Hughes† or its modification by Lord Rayleigh is probably best suited, using two coils of mutual inductance and a telephone as the observing instrument.

The inductance coils are usually in the form of two concentric rings, the inner being capable of rotation about the common vertical. The mutual inductance of such a pair of coils is a complex function of the dimensions and the angle between the planes at which the coils may be set. It is usual to calibrate the instrument by separate measurements of the inductance at different angles. A simpler arrangement, however, for mutual inductance is a short solenoid in the bridge circuit superposed coaxially upon a long solenoid in the battery circuit. Adjustment to silence in the telephone for interrupted currents is then made by including in the bridge circuit a greater or less number of turns in the outer solenoid. The mutual inductance is then very nearly proportional to the number of turns so included, and by suitable proportions in construction, the accuracy can be carried as far as the telephone for the receiver will permit.

For the measurement of inductance in coils on iron machinery, the ballistic galvanometer is frequently employed, either by the method of discharge for self-inductances, or induced quantity with mutual inductances. Mutual inductances connected by closed iron circuits present no difficulty when great accuracy is not required, since, as already observed, the self-inductances are calculable in these cases when the mutual inductance and the number of turns in the coils are known. It is much more difficult, however, to measure the self-inductance of the field magnet of a dynamo when the armature is removed, and when currents of the normal exciting strength are used in the measurement. The best attempt has been made apparently by observing the discharge effects of gradual small changes of a strong current passing through the coil, in circuit with a specially-arranged Wheatstone bridge.‡ If it were of sufficient practical importance, however, to measure such inductances with powerful currents, a recording instrument might be tried, having a very light and swiftly moving pointer, leaving a trace of its motion on a strip of moving paper, like Sir William Thomson's syphon recorder. If such a pointer were arranged to give an amplitude of movement at right angles to the paper strip, in proportion to the current traversing the coil, it would register the curve of discharge when the coil was short-circuited, in the manner described above. On a sufficiently enlarged scale, corrected perhaps for residual inertia in the moving parts, this curve would give not only the total quantity of discharge but its deviation from the logarithmic line of simple electro-magnetic discharge, would give the means of determining the characteristic of magnetisation in the iron.

Of far lesser importance than the selection of the practical inductance unit, but still well worthy of separate consideration is the selection of appropriate symbols to represent the unit briefly. It might, perhaps, be advantageous to represent the henry by a capital H, and the millihenry by the plain letter h. This notation would enable such an inductance as 50 henrys to be written as 50 H, and 50 millihenry as 50 h. The microhenry occurs so seldom that it would probably not need a symbol.

All measurements of precision should employ true ohms and not legal ohms in the computations. The best existing value of the true ohm is 1·0028 legal ohms.§

The correction is practically so small that it can best be carried out by altering the nominal standard temperature of the resistance coils adopted. These temperatures should be increased by 9·4 deg. C. for platinum silver, 6·5 deg. C. for German silver, and 13·15 deg. C. for platinoid. Thus a resistance box with platinum coils standardised for legal ohms (of 106·0 cms.) at 15 deg. C. would give true ohms of 106·3 cms. at 24 deg. C. as the best approximation, and this would be the standard temperature of the box for use in precise measurements of inductance.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

15,733. "Improvements in electrical signalling apparatus." E. DUCRETET. Dated October 7th. 8d. Claim:—The herein described apparatus for electrically signalling, consisting essentially of metallic plates insulated from each other and superposed, the number of which plates depends upon that of the signals to be produced from a distance, the surfaces of these plates, which are of optional form and dimensions, are perforated with holes, the number of which depends upon that of the combinations thus made beforehand, the whole being set in operation at will by a metallic peg, provided with springs, traversing all the said plates in order to extend to the last completing the entire circuit, the plates being moreover provided with holes outside the contacts of this peg for the signals not entering into the combination, and the apparatus having furthermore additional commutators.

17,424. "Improvements in joints for armoured electric conductors." J. D. F. ANDREWS. Dated November 2nd. 6d. When two straight lengths have to be connected, the inventor first cuts off part of the armour at the end of each length, so that the internal wires and their insulating coverings project beyond the end of the armour; he then joints the wires together, and cover the junction with insulating material in the usual way, preferably using material prepared for vulcanisation. Over this he slides a tubular sleeve, somewhat larger in diameter than the armoured conductor on one of the lengths, of which it had been placed before their junction. This sleeve has its ends made with lips turned inwards, so as nearly to fit the armoured conductors, and has a small hole through its side. The sleeve having been slid over the junction, so that each end of it overlaps the armour, he pours in through the hole molten fusible metal, which, on setting, adheres to the armour, and covers the insulating material surrounding the junction of the wires; this material, if suitably prepared, becoming vulcanised by the heat. 3 claims.

17,581. "Improvements in apparatus for regulating and commutating electrical currents, applicable for use in dynamo-electric machines, motors, and meters." H. F. JOEL. Dated November 5. 8d. Consists in the use of a piece or strip of sheet iron placed in front of the side of a fixed coil, between a coil and a movable wire, so as to cover the side of the coil, the iron shuts off, and to a great extent nullifies the action of the currents one upon the other, so that the movable wire is no longer repelled or attracted. If the iron strip is placed so as to cover one edge and a part of the coil only, the repelling or the attracting action is shut off on that edge or portion only, the other portion and edge of the coil will act upon the movable wire. 7 claims.

17,819. "Improvements in switches for making and breaking electric currents." A. SLATTER and W. RIXOM. Dated November 8th. 8d. Consists of the construction and arrangement of a "switch" which may be suitably enclosed within a casing of wood, porcelain or other suitable material, and worked by a suitable key, which may be separate from the "switch," and inserted therein when required through a suitable keyhole or opening. The said key engages with a link, one end of which is pivotted on a fixed centre, the other end of the said link is jointed or hinged to the end of a second link. This second link has a suitable "slot" formed lengthwise in it. Inserted in the said "slot" is a fixed pin, upon which the second link is free to slide. To the end of the said second link (farthest from the first link) is attached to or in contact with a suitable spring or springs so arranged as to pull (or push) the second link towards the pivot of the first link. Thus, when the first link is turned upon its centre by the hereinbefore-mentioned key (which is arranged and shaped so as to suitably engage with the first link), the second link is caused to slide upon the said fixed pin, and the said spring acts in opposition to this movement until the "dead centre" is passed, when the said spring accelerates the motion imparted by the said key, and the links move forward with a sudden quick movement independent of the key, the amount of such movement being limited by the length of the "slot" in the second link, or by suitable stops suitably arranged. 3 claims.

17,915. "Improvements in the operation of telegraph circuits and in apparatus therefor." C. A. GISBORNE. (A communication from abroad by D. H. Keeley, of Ottawa.) Dated October 11th. 8d. Consists of a rapidly reversing current at the receiving end of the line, and at the sending end a double current transmitter. The receiving instruments are polarised. If the sending key is depressed a current of one polarity, say +, goes to line and charges the conductor. If the current reverser at the distant end presents a − current to line, that current combines with the current transmitted, and affects the polarised receiver in one direction, say, closes it; when the current reverser presents a + current to line, it is opposed by the + current transmitted, hence no effect is produced in the receiver, which remains closed. If the key at the sending station is upraised, a − current goes to line. When the current reverser at the receiving end presents + to line, it combines with the − transmitted, and affects the polarised receiver in the direction opposite to that imparted before, and opens it; and when the current reverser presents − to line, it is opposed by the − transmitted, therefore no effect is produced and the receiver remains open. Hence the distant receiver is actuated by the distant battery under the operation of the sending key. 5 claims.

18,028. "Improvements in moulding plates for electric accumulators." E. DE PASS. (Communicated from abroad by La Société Jacquet Frères, of France.) Dated November 12th. 8d. Claims:—1. The process of moulding by dividing the core of the cells, whose transverse section is formed with twin inner bevelled sides, into two parts separated by a sliding surface determined substantially as described with reference to the drawings. 2. The mode of mounting of the half cores on two separate and independent pieces capable of being displaced in opposite directions according to a sliding surface determined as specified, and which leave, on the withdrawal of the cores, the cast plate confined all around its periphery, substantially as described with reference to the drawings.

18,526. "Improvements relating to the transmission and reception of telegraphic signals and to apparatus therefor." H. H. LAKE. (Communicated from abroad by S. D. Field, of America.) Dated November 19th. 8d. The sending apparatus comprise the follow-

* *Journal* of Institution of Electrical Engineers, London Journal, January, 1886.

† For another method of measuring small inductances with an alternating current, see an article by C. Steinmetz in the *Electrical Engineer*, vol. x., Nos. 130, 131. Nov., 1890.

‡ "Phil. Mag.," February, 1889. Dr. Sumpner.

§ "Report of the Committee on Electrical Standards," read before the British Associatioh, September, 1890. See the London *Electrician* of September 26th, 1890.

ing:—An operating key is made part of a local circuit, which includes an electro-magnet and a battery. The opening and closing of this key causes the magnet to attract and release an armature which is mounted on a pivoted lever, one end of which operates a pole-changing key, having continuity-preserving contacts which control the action of the line or cable battery. The other end of the pivoted lever at the limits of its movement closes a local circuit, which includes another electro-magnet and a battery therefor, but at points between the limits of its movement the latter circuit is open. The armature of the second electro-magnet is carried on a pivoted lever which operates a switch which in one position grounds the cable and in the other position closes the cable battery on to the cable. Owing to the fact that the first pivoted lever has a range of movement between its stops, during which the circuit of the second electro-magnet is open, it follows that the operation of the main key will be of the required character, namely, that upon depression a certain amount of current momentarily flows through the cable and then is immediately cut off and the cable grounded for static discharge, and on the release of the operating key current is again momentarily admitted to the cable, but in an opposite direction, and then immediately the cable is again grounded. There is, therefore, no chance for the errors of "personal equation" in attempting to judge the proper interval of time in admitting current to the cable, because a regular and determinate amount of current flows in the cable for each signal, and indicates the beginning and end only of such signal, corresponding to the make and break of the Morse system. The receiving apparatus is of the following character:—The inventor constructs an "iron-clad" magnet, which may be either permanent or electro, and in the latter case energised by a suitable local battery. This magnet is arranged to have two similarly polarised cores and a surrounding shell of opposite polarity, thus producing two annular fields of force. In these fields of force he suspended two fine coils, so wound that the arriving currents circulate therein in reverse directions. These coils are carried by a light aluminium frame, suspended partly by a silk fibre and partly by a torsion wire to a suitable capstain screw. The end of the cable terminates in the capstain screw, whence the work passes through the torsion wire, and by a light connection to the fine wire coils carried by the frame, and thence into a mercury cup, into which the frame dips, and from there to earth. The frame carries a cross bar, which is placed in light contact on each side with corresponding spring-retracted levers, which in the opposite direction are held by very thin wires, whose distant ends are connected to tension-regulating screws. Each of the wires forms part of a separate circuit, which includes a battery and corresponding coils, which are wound on the cores of a polarised relay, the arrangement being such that when the cross bar on the light aluminium frame is bearing with equal pressure on the small pivoted levers the strength of the two local batteries is exactly balanced on the polarised relay, and the latter is inert. When, now, an impulse arrives over the cable, it disturbs the position of the fine wire coils situated in the two annular fields of force, and thus more or less changes the pressure of the ends of the cross bar against the pivoted levers which form the terminals of the two thermic expansion wires. The equal amount of heat generated in these two wires by the respective batteries is at once changed by the movement of the cross bar. The result is that one of these wires becomes more or less cool and the other more or less heated, with a resultant change in the amount of current flowing through the two normally balanced circuits of the polarised relay, and at once the tongue of the latter is shifted. A local circuit for this relay is applied in the usual manner, and includes a local battery and an ordinary Morse sounder. 17 claims.

1890.

941. "Improvements relating to electric tramways and tramcars." A. L. LINEFF and E. H. BAYLEY. Dated January 18th. 11d. Has reference to improvements in or pertaining to an invention for which letters patent were granted, dated the 4th October, 1887, No. 13,447, and the invention consists in reducing the width of the slot opening of the channel in which the collector works; in making the contact for the return current independent of the state of the road, and thus prevent any possibility of sparking at the wheels; in providing means for an extra return circuit to carry the return current independently of the rails; in rendering the points or switches in the track more reliable and better adapted for the purpose; and in making the insulation of the main conductor more permanent, and the conductor less accessible to mechanical or electrical derangements than heretofore. 11 claims.

1,028. "A new or improved method of converting a direct or continuous electric current into an alternating current, and improvements in or relating to apparatus therefor." W. P. THOMPSON. (A communication from abroad by L. Gutmann, of Pittsburg.) Dated January 21st. 8d. This device embraces means for changing a direct or continuous current into an alternating current, which is not only merely alternating, but resembles in every respect the alternating current generated by the well-known alternating current generator. The current obtained by the invention is not simply constituted of impulses of alternate direction, but each impulse varies gradually from zero to maximum of the given strength of current of the direct current dynamo or battery, and then gradually from maximum to zero. 6 claims.

1,329. "Improvements in sockets or holders for incandescent electric lamps." C. R. BONNE. (Communicated from abroad by W. Thompson, of Dresden, Germany.) Dated January 25th. 6d. The object of this invention is to reduce the cost of construction; to reduce the number of parts in the device; to secure more perfect contact of terminals; to prevent or reduce the liability of producing a spark at said terminals to simplify and render more convenient and easy the operation of switching or making or breaking a circuit; to render the device more durable, and generally to secure other advantages and results. 3 claims.

2,234. "Improvements in electro-mechanical movements, chiefly designed for regulating the carbons in electric arc lamps, and for similar purposes." S. E. NUTTING. Dated February 11th. 8d. The object of the invention is to make an electro-mechanical movement that will be proportional at all times, and under all circumstances, to the quantity of the electric current varying with every variation in the quantity of such current. 5 claims.

THE ELECTRICAL PROPERTIES OF SEMI-PERMEABLE WALLS.

AN interesting paper by W. Ostwald was recently published in the *Zeitschrift für Physikalische Chemie*, upon the electrical properties of semi-permeable walls.

Suppose a salt to be dissolved in some solvent, then a "semi-permeable" material is one which allows the solvent to pass through it but does not permit of the passage of the dissolved salt. It might be imagined that the permeability of any given material depends upon the nature of the given salt as a whole, but this is not the case; Ostwald has found that it depends upon the nature of each of the ions. For example, ferrocyanide of copper is permeable by potassium chloride because it allows of the passage of both the chlorine and the potassium ions; it is not permeable by barium chloride because, although it presents no obstacle to the passage of the chlorine, the passage of barium ions is prevented. Again ferrocyanide of copper is not permeable by potassium sulphate, for although the potassium ions are allowed to pass, the passage of the SO_4 ions is prevented.

Ostwald submitted various solutions of salts to electrolysis, and he found that if a solution, the ions of which are unable to pass through a semi-permeable material be submitted to this decomposition, the electrodes being separated by a semi-permeable wall, *the latter will itself act as a metallic electrode.*

The method of performing the experiment is essentially as follows: Two glasses are filled with a normal solution of sulphate of copper and then connected together by a U-tube, the ends of which are covered over with parchment paper.

The U-tube itself is filled with a normal solution of potassium ferrocyanide, so that a layer of copper ferrocyanide, formed on the paper. A current of electricity was then passed from one glass to the other. In a little while it was observed that metallic copper was deposited on the surface of the parchment paper in the glass which contained the positive electrode. The mechanism of the interesting process appears to be that the positively-charged copper ions come in contact with the film of copper ferrocyanide, through which they are unable to pass, hence they are obliged to give up the charges of electricity which they possess, and are deposited in the metallic state upon the surface of the parchment paper.

Precisely the same thing happens to the negatively charged $Fe\,Cy_6$ ions at the other side of the film. These, by losing an equivalent of negative electricity become converted into the triad ferricyanide ions.

At the other film the potassium ions, which can permeate the copper ferrocyanide, pass through and unite with the SO_4 ions of the copper sulphate, and thus electrical equilibrium is established.

This view of the peculiar solution behaviour of semi-permeable materials towards different ions affords an explanation of the fact noticed some time ago by Becqueril namely, that when a tube containing a solution of nitrate of copper is placed in a solution of sulphide of sodium a deposition of copper takes place in the interior of the tube.

In Becqueril's case the sulphide of copper first formed permits the passage of the NO_3 ions but prevents that of the copper ions. The NO_3 ions coming in contact with the sulphide of sodium institute the following changes:—

$$2\,NO_3 + 2\,Na_2\,S = 2\,Na\,NO_3 + K_2\,S$$
$$2\,(-)\quad 4\,(+)\,4\,(-)\qquad 2\,(+)\,2\,(-)\,2\,(+)\,2\,(-)$$

Now if the positive and negative charges expressed in the above equation be counted it will be seen that there are six negative and four positive charges before the reaction takes place, and four negative and four positive charges after the reaction is over. The negative charges set free combine

with the positive charges of the copper ions on the other side of the film, and the metal is thus deposited.

Ostwald enters into an elaborate argument to show that many observed electro-physiological phenomena may be explained by the above facts with regard to semi-permeable materials, for instance that of the secondary resistance of albumin noticed by Dubois Reymond in the *Monatsberichte Besl. Akad.* Vol. i. p. 816.

These facts too help to explain how it is that damp membranes, may, under certain circumstances act as perfect insulators.

The original paper may be consulted in the *Zeitschrift für Physikalische Chemie*, Vol. vi, pp. 71-82.

CORRESPONDENCE.

Electrical Miners' Lamps.

In your leader of 26th inst., you bring in the name of the Inventors' Institute in a way that, in justice to the society, cannot be passed without remark.

The Inventors' Institute has nothing whatever to do with the promotion of companies, nor in any such commercial or financial business. But at its evening meetings it does put forward for observation and discussion inventions which are considered worthy of attention.

On such occasions, also, it invites scientists outside of its own privileged list of members to contribute to a knowledge of the subject. Further, such meetings are presided over by some specialist of eminence.

It is therefore unjust to write in language inferentially attributing to the institute the promulgation of baseless claims for inducing the public to contribute to the financial benefits of promoters.

As there was an ample display of M. Gauzentes' inventions, it is to be regretted that these were not carefully studied by the writer of your leader. To defend statements is not my present intention, but I would take exception to the sweeping condemnations of primary batteries.

We all know they have not established a commercial status in the face of the enormously superior general advantages possessed by the dynamo machines.

Nevertheless, the primary battery has many important qualities, that it is unjust to scoff at attempts to advance its capabilities. In the end, they may accumulate in the production by chemical evolution of electricity of, at least, a powerful competitor with steam engine produced electricity.

Primary batteries are not the only things upon which charlatans have gulled the public. The amount of money squandered on dynamos, arc lights, and electrical systems exceeds a hundred times the money extorted by speculators in primary batteries. There is admittedly value in a scientific combat, but condemnation by inuendoes is, in my opinion, as unjust as it is injurious.

S. J. Mackie, *Hon. Secretary.*

December 12th, 1890.

[We utterly fail to appreciate our correspondent's references to the Institute in which he holds the post of honorary secretary. Not a word in our leader can be construed as reflecting on it; indeed, the only mention of the Inventor's Institute is to the effect that the paper on which we commented had been read there. Again, Mr. Mackie's strong defence of primary batteries is evidently made in forgetfulness that a few days before, in a letter addressed to a contemporary, he thus delivered himself:—"I have a pretty wide experience, extending over many years, of primary batteries, and I am by no means sweet on them, as the saying goes."—EDS. ELEC. REV.]

Improvements in Telephone Switchboards.

I am glad that I have brought out Mr. Kingsbury, and beg to thank him for the trouble taken to initiate us in the various details pertaining to his improved switchboard, and although his explanations in answer to my enquiries are somewhat unsatisfactory, they will do as far as I am concerned.

No, I have always been considered, or looked upon, as a Scotchman, I am happy to say; but my letter of the 20th ult. having been written in England, caused me to write "England's Electricians," otherwise I might have said, quite as appropriately, "Scotland's Electricians," or, probably, "Scotland for Ever." I am too well known by the most eminent electricians of the country for any invention or improvement of mine to be ridiculed by them, and, in fact, my inventive propensities are so great, that I feel I should be a second "Edison."

The savour of irascibility in Mr. Kingsbury's letter does not agree with my stomach, probably its potential is wrong, and he may regret such by and by.

I am not now altogether decided that I will trouble you with the intended description of my system of switching, although such is an A B C matter to me, after the sarcastic and ungentlemanly remarks in his letter in your previous isssue; but if I do, it shall be in a manner interesting to electrical engineers, and not discreditable to—I better say, to be more accurate—

An Electrician and Engineer Nearly All His Life.

P.S.—I wonder if the patent No. 7,465, in your issue of the 26th ult., is by the same party, as it may anticipate my schemes.

January 3rd, 1890.

[This letter is so little to the point that we cannot imagine Mr. Kingsbury giving it a second thought, and the correspondence on this subject may now with advantage be brought to an end. So long as it was confined to a discussion between men of long and varied experience the opinions expressed formed interesting reading, but it has now dwindled into mere inanity.—EDS. ELEC. REV.]

Force, Energy, Power, &c.

In the last number of your journal, one of your correspondents signing himself "Foot-Pound," indicates a geometrical process for giving beginners clear ideas as to force, energy, power, and work. It is, unfortunately, impossible to accept "Foot-Pound's" mode of representation, for the *power* and the *work* being both represented by a *volume*, they would be physical quantities of the same nature, which is quite inaccurate. In fact, the power is the quotient of the work divided by the time, and not the work produced in the unit of time, as the figure would lead one to think. According to this mode of representation, energy and work would not be quantities of the same nature, since energy is represented by a *surface* and work by a *volume*.

In reality, energy is a physical quantity of the same nature as mechanical work, heat, and electrical work, only mechanical energy is measured by foot-pounds or kilogrammetres, thermic energy or heat by calories, and electrical energy by voltcoulombs or joules.

E. Hospitalier.

A Forecast of the Electric Railway.

In the *Illustrated London News* for November, 10th 1855, there appears a description of a proposed submarine railway under the Straits of Dover, it was to consist of an iron tube built up of sections and made water-tight, and to be held down by mooring chains to the bed of the sea. The motive power the author of the scheme says *might be electricity*, and that the lighting might very evidently be the same medium.

J. H. Gurney, Jr.

Chromic Acid Battery.

Should feel obliged of you would tell me the best proportions of the materials necessary for chromic acid battery (not bichrom potash).

Tynesider.

[Perhaps some one of our readers could give an answer to this query.—EDS. ELEC. REV.]

The Electro-Deposition of Copper.

I notice in your issue of the 28th November a letter from Mr. John Hill referring to Mr. Wilde's patents for making electro-copper rollers. I may say that some years ago I was for a considerable time connected with the Wilde works at Manchester, during which period this process of producing compound iron and copper rolls was in full operation, and I quite agree with Mr. Hill that the process proved very well adapted for making calico-printing rolls and the like; and that it is, moreover, quite true that a large number of most excellent rolls have been made this way, but, at the same time, it seems very misleading to confound what Wilde did do with what Elmore by his method does do and can do.

Wilde's process was essentially a plating process; his primary object was to cover with a coherent coat of copper the roll, the tube, the ram, or whatever the article was that he wanted to face or to protect, and the gist of his patent is the means employed to promote an intimate union between the copper and the surface of the iron core. He does not say one word about the production of copper-fashioned articles on detachable mandrils; he certainly did not practise such a manufacture, and I do not think ever contemplated it.

His first patent, No. 4,515, 1875, chiefly relates to means for agitating the solution, so that every part of the article being plated is evenly fed with the sulphate. In his second specification, No. 3,569, 1876, he describes arrangements for making up the total thickness of copper by several superimposed coats or layers, the roller being removed from the bath and burnished after each layer had been deposited, and so on till the desired number of coats had been reached and the required thickness attained; and it goes on to state in the specification that this was done with the double object of forcing the deposited copper into closer contact with the iron, and detecting any want of adhesion between the two metals. There is nothing here mentioned about making copper cylinders to be used independently of the core; indeed the specification only describes means for preventing the copper becoming detached from the iron.

As a matter of fact, the plan of taking the roller out and burnishing at the intermediate stages of depositing was not followed, for, as Mr. Hill mentions, it was found that by simply stopping the deposition every few hours, and exposing the roll to the air for some minutes, a succession of coats were produced which were not liable to strip from the core.

Why this gain in adhesive effect should result from merely interrupting the continuity of deposit seems rather difficult to explain; however, it certainly occurred. It is, I think, open to some doubt as to how far a burnishing action by itself really does promote adhesion between a coat of copper and the iron core or mandril, there can be no kind of welding action between the two metals, and although a moderate amount of pressure may have a beneficial result, through bringing more particles of copper into intimate contact with the iron; yet if the burnishing or condensing action is carried beyond a certain limit, the softer metal will expand, as a whole, and separate from the iron core, and Elmore uses exactly this arrangement to get his finished pipes and tubes off the mandril. As a matter of fact, I believe Wilde also made tubes sometimes this way, but they were accidents; and, of course, these tubes would be useless. His idea was to cover an *article with copper*, and not to produce a *copper article*. Now the aim and methods of Elmore have been different. He saw that a demand was arising for homogenous seamless copper pipes, cylinders, rings, and such things, and he set to work to produce them, not by depositing the metal anyhow, and trying to consolidate it by external pressure on the exterior afterwards, but by causing the deposition to take place under the continuous pressure of a burnisher, which exercises a powerful squeezing action on the particles as the growth proceeds. The two systems of getting a dense deposit may, I think, be fairly compared to the old method of getting a close grained ingot of steel by hammering it, and the later practice of casting it under pressure. In one case the action is to some extent local, near the surface; in the other it is uniform throughout the mass.

In Elmore's patent, 4,499, 1885, the lines from 10 to 25 very lucidly point out the object and the application of the continuous burnisher, and attention is directed to the fact that the article being produced builds up under this action with a homogeneous growth till it attains a finished size, without there being any necessity to remove it from the solution, thus preventing any scale or oxide forming to make layers or strata in the deposit. A pipe may be made a foot thick by this process, and the substance of the metal in the inside inch and the outside inch, and in the interior will all be of the same coherence and density, a result one could never hope to attain by any burnishing or rolling of the finished article.

Elmore mentions Mr. Wilde's patent of 1876 in his specication, and points out that they do not relate to the same thing.

Independently of the manufacture of plain tubes and cylinders. the travelling burnisher method renders possible the facile production of a vast number of copper articles and utensils used in the manufactures, and which now have to be built up and rivetted or brazed, with all the attendant danger and expense. For instance, copper vacuum pans, brewing kettles, stills, jam boilers, boiling and bleaching kiers, &c., can be thus made with the metal homogeneous, dense, of great strength, and without seam, and almost to the exact size and shape, and exceedingly cheaply, as almost crude copper can be used, and the attention required is small. Surely Mr. Hill would not imply that results of this kind conld be obtained by the methods he describes. No one admires the genius of Mr. Wilde more than I do, and I think the rising generation don't half realise what he did do in the way of electrical development; still, I don't see that he in any way anticipated the Elmore process.

Elmore is admitted to have introduced the practice of continuously consolidating the metal during the act of deposition. It is acknowledged that in this way he obtains very superior results, and it is proved to be a cheap and reliable process; and, as far as I know, these are just the points the advocates of the Elmore Company have claimed for it.

Percy R. Allen, *A.M.I.C.E.*

December 8th, 1890.

[Our correspondent may have sources of information not generally available which satisfies him of the correctness of his concluding remarks, but when he implies that there is a general acknowledgment that the results of the Elmore process are very superior and proved to be cheap, we are obliged to differ, for the simple reason that there is no information generally available upon which such conclusions can be formed. Until articles produced by the Elmore process are in the market we do not see how there can well be any general acknowledgment one way or the other. Mr. Allen states very fairly the difference between Wilde's and Elmore's processes as contemplated by the respective patents. So did Mr. Hill. Only by reading the latter portion of his letter, apart from the rest, could any impression be formed such as Mr. Allen corrects. Differences on questions of fact we must leave our correspondents to settle, but we may remind Mr. Allen that Mr. Hill stated in the letter we published on November 28th: "I have now before me a 400 feet length of a copper wire turning, and an electro-copper cylinder, 36 inches long, and 5 inches diameter, produced in the manner described, 14 years ago." Mr. Hill sent us a sample of this tube and turning. If it was an "accident" it was a very substantial one. How much more useless it may be than a tube of similar size and section produced by the Elmore process we have no means of judging.—EDS. ELEC. REV.]

I see that the New York *Electrical Engineer*, in its issue of the 24th ult., gives me credit for proving, "in nearly two columns," that "identically the same amount (*sic*) of copper is deposited, whether there be employed a current of a large number of ampères at low voltage or a smaller current at a correspondingly high voltage." Your contemporary will, no doubt, think me very inconsistent when I say that I emphatically deny the truth of this general proposition, which he considers "so obvious that it should require no special or long-winded explanation at this late day."

Is it too much to expect ordinary accuracy of statement on the part of writers on scientific subjects?

Desmond G. FitzGerald.